SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER 1906.

GENERAL PHYSICS.

1520. *Repeated-impact Testing Machine.* **T. E. Stanton.** (Engineering, 82. pp. 33–34, July 13, 1906.)—The machine is intended to break specimens under a large number of small blows. The falling weight is raised 45 times per min. by a cam, the height of fall being adjustable from 0 to 3½ in. The specimen, ½ in. diam., with a V-notch turned 0·05 in. deep, is rotated through 180° after each blow, by means of a crank and slotted link mechanism to which it is attached by a semi-Oldham coupling, in order to avoid interference with its free vibration after the blow. The supports are 4½ in. apart. If the fall of the hammer is adjusted so that the specimen will bear at least about 2,000 blows, there is no appreciable permanent set until a comparatively short time before fracture. Cracks develop on each side of the piece and proceed inwards as the test continues. The following is an example of tests on a sample of mild steel :—

Fall of hammer, inches..................	0·77	0·50	0·30
Energy of blow, inch.-lbs.	3·62	2·85	1·41
Number of blows for fracture	4,950	12,400	44,634

F. R.

1521. *Depth Indicator for Torpedo Boats.* (Engineer, 102. p. 46, July 13, 1906.)—The experiments of Marriner and H. Yarrow [Abstract No. 46 (1906)] have shown that in the case of torpedo-boats and destroyers, when running at anything but slow speeds, there exists a relation between depth of water, speed of vessel, and fore-and-aft inclination of hull such that if two of these are known the third can be determined. The instrument described, made by Elliott Bros., is based on this discovery, the object being to indicate when the vessel is running into shallow water, and at the same time to enable the depth of water under the vessel to be approximately known by the officer in charge. The apparatus consists of a series of six spirit-levels which can be separately set and clamped at any small inclination. These levels are supported by pillars on a hinged base, the upper part of which can be levelled by means of an adjusting screw and a fixed spirit-level. To use the instrument it is fixed, say, on the bridge and placed level when the vessel is at rest. Any change of trim can be allowed for and adjusted from time to time, so that the base is always level. Taking 30 ft. as the least safe depth desirable, Yarrow has given 1½ in. in 20 ft. as the inclination for 16 knots in

30 ft. depth, and 2¼ in. in 20 ft. for 18 knots. No. 1 hinged level is then set to the former inclination, and if the bubble passes over to the other side of the level at 16 knots it shows that the depth is about 30 ft. No. 2 level is similarly set, to the larger inclination. The inclination for boats of each type has to be experimentally determined. L. H. W.

1522. *Static Method of comparing Densities of Gases.* **R. Threlfall.** (Roy. Soc., Proc. Ser. A. 77. pp. 542–545, June 21, 1906.)—A method is described by which the densities of two gases may be compared by balancing two columns of gas by means of water in a micro-manometer. The gas-columns were contained in composition pipe and were 20 m. in height; when air and producer gas were compared together the difference of pressure recorded by the manometer was about 0·35 cm. of water, and was measured to 0·0001 cm.; the density of the producer gas was calculated to be 0·001102 gm. per c.cm. at 8° and 760 mm., whilst the analysis of the gas gave 0·001089. T. M. L.

1523. *Transition from the Liquid to the Solid State, and the Foam-structure of Matter.* **G. Quincke.** (Roy. Soc., Proc. Ser. A. 78. pp. 60–67, July 21, 1906.)—All liquids resemble water in forming, as they cool, oily foam-walls, which may be very thin and invisible. The shape and position of these foam-walls become visible, on freezing or thawing, in six different ways. Examples are given from a wide range of substances—water, benzene, metals, salts, minerals, &c. The walls and contents of the cells consist of heterogeneous substances. The observed foam-structure or cellular structure of solids may be explained as due to traces of foreign matter, but the author is of the opinion that "even in perfectly pure liquids, oily heterogeneous liquid can separate out on cooling." This liquid may, however, consist of an allotropic modification of the substance. T. M. L.

1524. *Thermal Variation of Modulus of Elasticity.* **A. Wassmuth.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 223–305, March, 1906.)—A continuation of the author's previous work. Thin bars of different metals were supported on knife-edges, the ends of the bars being fastened (beyond the knife-edges) into light but sufficiently rigid aluminium rods. A couple of iron-constantan, secured in a very small hole in the centre of the bar, served to measure the cooling on suddenly loading at the ends. From this the thermal variation ϵ of the modulus of elasticity E is calculated. The following results were obtained, and agree fairly well with those of Schaefer and Katzenelsohn:—

Metal.	$\epsilon \times 10^{-4}$.	Metal.	$\epsilon \times 10^{-4}$.	Metal.	$\epsilon \times 10^{-4}$.
Platinum	1·07	Nickel	3·247	Silver.........	7·48
Palladium	2·05	Copper	3·59	Aluminium..	19·98
Steel	2·64	Gold	4·09	Zinc	34·9

[See also Abstracts Nos. 1021 (1903), 574 (1904), and 5 (1906).] A. W.

1525. *Measurement of the Elastic Limit of Metals.* **Guillery.** (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 3. pp. 223–231, July 1, 1906.)—The variation of electrical resistance with tensile load was observed for several steels either as forged or treated; the difference between a standard resistance and the resistance of the specimen, as shown by the deflection of a galvanometer, was traced on a screen which moved according to the increase of load. The curves given are roughly similar to ordinary stress-strain diagrams. The increase of resistance without increase of load at the elastic limit is much more marked in a Martin steel than in a Thomas steel of similar type, but does not occur in some hard steels. In several cases the curves obtained from overheated steels were concave towards the axis of loads. **Mesnager** made comparison tests, using an autographic stress-strain recorder. Numerically these results differ from the author's, being generally about 10 per cent. lower. Yield-points are actually recorded in the quenched and tempered specimens of hard steels. The author's apparatus, however, was admitted to be somewhat imperfect. F. R.

1526. *Shear Strength of Structural Materials.* **C. Frémont.** (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 3. pp. 205–212, July 1, 1906.) —The author eliminated the friction between the steelings and the sheared faces, by filing away the sheared face from time to time during the shearing; it was then found that, in single shear, the shearing stress was 0·4 of the maximum tensile stress for the same material. Hence the apparent elastic limit in shear will be 0·4 of that in tension, as friction does not come into play until the elastic range is exceeded. This law has been verified for irons and steels of from 19 to 65 tons per sq. in. tensile stress. In double shear the shearing stress was also reduced by the same mode of eliminating friction, but was in any case less than in single shear. The formula $T = (C - 7{\cdot}5)/0{\cdot}34$ represents the results of a series of tests; here T and C are the maximum tensile and shearing stresses respectively in kg. per sq. mm. A suitably ruled diagram on tracing paper can be superposed on the shear load-deformation curve, and the latter can then be read off as a tensile stress-strain diagram. F. R.

1527. *Strain in Twisted Shaft where Contraction Occurs.* **A. Föppl.** (Zeitschr. Vereines Deutsch. Ing. 50. pp. 1032–1035, June 30, 1906.)—The mathematical treatment for the case of a cylindrical shaft whose radius alters from a to b, the corner being rounded off with radius of curvature r_0, involves the theory of elasticity, and the solution has been obtained by the author (K. Bayer, Akad. München, Ber. 35. p. 249, 1905). In the present paper the author arrives at his results by analogy with hydrostatics. He has shown that the lines of equal stress in the shaft can be represented by the stream-lines of a fluid passing through a tube coincident with the external boundary of the shaft, and if τ is the tangential stress at a point distant ρ from the axis, then the fluid velocity at the point is proportional to $\rho^2\tau$. The equation to a trajectory (n) cutting the stress lines at right angles is $d\tau/dn = \tau(\cos\alpha)/\rho + \tau/r$, where r is the radius of curvature of the stress line and α its inclination to the axis at a point ρ from the axis. When the shaft is uniform this reduces to $d\tau/dn = \tau/\rho$ or $d\tau/d\rho = \tau/\rho$, which shows that in this case the stress is proportional to the distance from the axis. By considering the boundary conditions at the contraction the author concludes that the greatest stress at the contraction is equal to that of a hollow cylinder of radius a and of thickness ηr_0, where η has a value about 1·5. A graphical solution of the equation for τ is then given and some general conclusions drawn. A. W.

1528. *Behaviour of Cast Iron under Slowly-alternating Stresses.* **S. Berliner.** (Ann. d. Physik, 20. 3. pp. 527–562, June 26, 1906. Extract from Dissertation, Göttingen.)—The strain after successive tension and compression loadings to stress $\pm p'$ is, at any stress p, approximately—

$$f = \int_{p'}^{p} a\,dp + \frac{c}{4}(p - p')^3 + \text{const.};$$

a is a function of p, and c is nearly constant. The equation of the "traverse curve" joining the peaks of the loops obtained by loadings and unloadings of successively diminishing range is—

$$\lambda = \int_{p_1}^{p} a\,dp + c(p - p_1)^3 + \text{const.},$$

λ being the strain, p_1 the lower limit of stress. For the virgin material—

$$\lambda = \int_{0}^{p} a\,dp + cp^3.$$

With fair approximation, the following may be respectively used in place of the above—

$$f = a(p - p') + \frac{c}{4}(p - p')^3 + \text{const.}$$
$$\lambda = a(p - p_1) + c(p - p_1)^3 + \text{const.}$$
$$\lambda = ap + cp^3.$$

The elastic time-effect which can be developed in conjunction with these strains is of practically equal amount at corresponding points on each of the curves. The experiments also extended to the corresponding questions in torsion. F. R.

1529. *Speed of Loading in Tensile Tests.* (Eng. News, 55. p. 727, with Discussion, June 28, 1906. Committee Report read before the Amer. Soc. for Testing Materials, June 21, 1906.)—From numerous tests in which the rates of pulling were from $\frac{1}{64}$ in. to 6 in. per min., there seems to be only a small tendency to higher results with increased speed, which is more marked in tyre and axle steels than in milder steels, but cannot be quantitatively expressed from the data. The committee recommends maxima of 6 in. per min. for boiler and bar specimens (8-in. testing length), and 3 in. per min. for forging specimens (2-in. testing length). Yield-point should be determined at speeds of ½ to ¾ in. per min. *In the discussion,* **P. Kreuzpointer** stated that although the experiments did not include tests of iron, he had found that no appreciable influence of speed of loading is to be expected with this material. F. R.

1530. *Stability of Submarines.* **W. H. White.** (Roy. Soc., Proc. Ser. A. 77. pp. 528–537, June 21, 1906.)—When a submarine is in motion hydrodynamical forces come into play from the stream-line action of the water, and these will affect the stability. White insists that these forces can only be examined experimentally. **J. H. Jeans.** (Nature, 74. p. 270, July 19, 1906.)—Jeans gives a method of deducing mathematically their approximate value. The principle employed is that an ellipsoid moving through still water tends to turn so that its smallest axis is in the direction of motion. The submarine is taken (for a first approximation) to be a cigar-shaped spheroid immersed in an infinite ocean, and taking the case of a vessel

150 ft. long and 12·2 ft. broad, the author calculates that the metacentric height is diminished by the motion by an amount 0·95 V^2/g, where V is the velocity. White gives as the metacentric height of an actual submarine 37 ft. when awash on an even keel, and only 45 per cent. of this, say 16½ ft., when trimmed to an angle of 4°. V^2/g, when $V = 10$ knots, has a value of about 9½ ft., so that the effective metacentric height would be reduced to about 28 ft. on an even keel, and to 7½ ft. when trimmed 4° by the stern. Judging from a diagram given by White, the metacentric height would vanish altogether for a trim of about 7°. So that a submarine moving ahead at 10 knots, even under perfect conditions, might apparently be expected to founder if its inclination at any time reached as much as 7°. The author points out that a great number of factors have been omitted in the calculations, the most important being probably the proximity of the surface and the consequent formation of surface-waves. **W. H. White.** (Nature, 74. p. 270, July 19, 1906.) White here points out that from photographs of submarines moving near the surface, showing the singular and irregular character of the surface-waves, it is evident that it is impossible to represent the conditions of practice by purely mathematical investigation; hence the necessity for experiments. But Jeans' calculation furnishes fresh reasons against the tendency to increase the under-water speeds of submarines. In the diving condition, when the height of the centre of buoyancy above the centre of gravity is (for existing types of submarines) less than 1 ft., a speed of less than 6 knots might render the vessel unstable. The existence of superstructures involves a departure from the cigar-shaped spheroidal form, but cannot be accompanied by any such decrease in the moment of the couple resulting from the stream-line forces as would secure, or even add sensibly to, the safety of the submarine when moving at high speed under water.

A. W.

1531. *Barometric Variation of Long Duration over Large Areas.* **W. J. S. Lockyer.** (Roy. Soc., Proc. Ser. A. 78. pp. 43–60, July 21, 1906. Nature, 74. pp. 352–354, Aug. 9, 1906.)—Having in conjunction with N. Lockyer, shown the existence of a barometric see-saw of about 3·8 years occurring between two large regions nearly antipodal to each other, the centres being approximately India and Cordoba (Argentine Republic), and having subsequently proved that this see-saw was almost worldwide in its extent [see Abstracts Nos. 874 (1903) and 2841 (1904)], the author investigates whether barometric variations of long duration display a similar relation. The investigation is so far confined to India, the East Indies, Australia, and South America. For South America very few data are available. As regards short-duration changes, the average difference between a barometric minimum and the succeeding maximum amounts to 0·035 in. for India (Bombay, Madras) and to twice as much, 0·074 in. for Australia (Sydney, Melbourne, Adelaide); the changes in Australia are thus on a much larger scale; South America (Cordoba, Goya, San Juan in the Argentine Republic, Santiago in Chili, and Curityba in Brazil) goes with India, average difference 0·38 in. Similar relations are found for the long-duration changes. The average difference between maximum and minimum is 0·026 in. in India, 0·052 in Australia, and 0·039 in. (from 0·032 to 0·045 in., the range being wider in this instance) in South America. The percentages of the amplitudes of the long- and the short-period variations, referred to the mean annual variations, are again highest in Australia (35 per cent.), Santiago coming next (33 per cent.). The study of the Australian meteorology therefore deserves particular attention. When the short-period variations are expressed in percentages of the annual swing, these percentages decrease from 28·7 to 6·4 in India, as the latitudes increase from nearly 7° (Colombo) to 32° (Ismail Khan). The long-period barometric variation is in India nearly the inverse of the sun-spot cycle of 11 years, years of high pressures coinciding, as a rule, with years of small spotted-areas. The interval between the principal maxima is for Australia and South America 19 years, but the Australian maximum precedes the other by about 6 years. The 19 years' period seems to be due to solar action modified by terrestrial causes. The curves show similarities, but an explanation for the modification of the 11 years' period of India into a 19 years' period has not been found. The Australian period of 19 years, the author subsequently learned, had been pointed out by W. B. Clarke in 1846. The author acknowledges suggestions by W. N. Shaw. H. B.

1532. *Sand Blast for Testing Materials.* **H. Burchartz.** (Eng. Record, 54. pp. 38–40, July 14, 1906.)—A portion of the surface of the specimen 6 cm. diam. is exposed to the blast for 2 min. Dried steam at 2 atmos. pressure and quartz sand which passes through a 120-mesh (per sq. cm.) sieve are used, in a suitable apparatus of which drawings are given. There is an arrangement for holding and traversing the specimen across the blast. The loss of weight is observed and reduced to volume removed per sq. cm. of exposed surface. Results are given in the following table, with comparison results by Bauschinger's grinding method. Photographs of the surfaces after test are given :—

	Cub. cm. per sq. cm. Removed.			Cub. cm. per sq. cm. Removed.	
	By Bauschinger Machine.	By Sand Blast.		By Bauschinger Machine.	By Sand Blast.
Granite	0·10	0·09	Blast furnace slag	0·29	0·15
Porphyry	0·17	0·12	Granitoid plates...	0·25	0·16
Trap..................	0·25	0·15	Concrete plates ...	0·56	0·27
Slate..................	0·59	0·28	Pine	0·10	0·07
Sandstone	0·85	0·77	Red pine.............	0·19	0·10
Limestone	2·04	1·26	Linoleum A	0·029	0·021
Clay plates	0·08	0·06	Linoleum B	0·035	0·024
Clinker plates......	0·15	0·19	Floor coating ...	0·41	0·32
Paving clinkers ...	0·26	0·16	Hygiens flooring	—	0·03
Blast furnace slag	0·25	0·12			

F. R.

1533. *Californian Earthquake of April* 18, 1906. *Preliminary Report of State Commission.* (Nature, 74. pp. 285–286, July 19, 1906. Eng. Record, 54. pp. 62–65, July 21, 1906.)—The Commission appointed by the Governor of California co-operated with the American Society of Civil Engineers. The Coast Ranges of California are crossed obliquely by a line of rupture, which in general follows a system of long, narrow valleys. In some parts it passes over mountain ridges and shoulders in what is technically known as scarps—low, precipitous walls—at the base of which ponds or trough-like depressions are frequently found. The line of rupture can be traced from Point Arena to Mount Pinos, over a length of 375 miles, in a remarkably straight course; in some districts two parallel lines seem to occur. The movements which have taken place along the plane of rupture extend far back into the Quaternary. The April earthquake was one of these movements, due to stresses in the earth's crust. The newly-formed rift has a length of 175 miles, possibly of 300 miles. It is a furrow, generally several feet wide, noticeable on all fences, roads, streams, conduits, &c. There has been a horizontal displacement on a nearly vertical plane; most probably both sides moved in opposite directions. The amount of horizontal dislocation varies between 6 and 16 ft. In Mendocino and Sonoma Counties a differential vertical movement is observed in addition to the horizontal dislocation; further south this elevation of about 4 ft. seems to pass into a depression. The survey, and the longitudes and latitudes, will have to be revised.—**A. de Lapparent** (Comptes Rendus, 143. pp. 18–20, July 2, 1906) agrees with the preliminary conclusions as to the character of the earthquake. H. B.

1534. *Formation of Ground-Ice.* [*Anchor Ice.*] **J. de Schokalsky.** (Comptes Rendus, 143. pp. 261–263, July 23, 1906.)—The formation of ice at the bottom of rivers and lakes has been little studied. When L. de Vladimiroff drew attention to it in 1904, it was found that the phenomenon was well known in the rivers and also lakes of Russia, Siberia, and Turkestan. The author made observations in connection with the projected water supply for St. Petersburg from Lake Ladoga. The ground-ice differs from the surface ice, and the blocks, which may be as large as 1 m. in cubic dimensions, grow from small crystals which are originally united only at their bases, but become welded. Four categories may be distinguished: small globular crystals as in *firm* ice—this form appears in November, and disappears in January; scaly crystals; lamellæ from 1 to 4 cm. in length, often grouped under 60°; large lammelæ, giving large blocks of 1·60 × 1·12 × 0·35 m. When the thickness of the ground-ice exceeds 0·18 or sometimes 0·35 m., the ice rises, occasionally breaking the ice sheet on the surface. The temperature of the air varied between —2° and —12°C.; the water was at 0° and a little colder, probably —0·15°, at the bottom. A Negretti-Zambra thermometer lowered into the water became covered with an ice crust within 5 min., and ground-ice has been found at a depth of 7 m. [See also Abstract No. 548 (1906).] H. B.

1535. *Electrical Resistance of Natural and Artificial Mineral Waters.* **D. Negreano.** (Comptes Rendus, 143. pp. 257–258, July 23, 1906.)—The fairly constant resistances of four mineral waters from Roumania and three from France range from 27 to 1,280 ohms/cm. at 18° C. The resistance decreases with rising temperature according to $R_t = R_{18}[1 - \alpha(t - 18)]$, where α is about 0·02, ranging from 0·019 to 0·027 in these seven cases. The resistance is said to allow of making a distinction between natural and artificial mineral waters; the two examples given are: natural Vichy water—resistance 140, artificial 112 ohms; natural Cachat water 1280, artificial 1120 ohms. [See also Abstract No. 1192 (1906).] H. B.

1536. *Magnetic Inclination in Prehistoric Times.* **P. L. Mercanton.** (Comptes Rendus, 143. pp. 139–140, July 9, 1906.)—By careful examination of many specimens of ancient pottery the author has been enabled to detect evidence of the magnetic constants which obtained at the time of their manufacture. Their supposed ages vary from neolithic to 1500 B.C. In most cases the magnetic field was apparently slightly inclined to the axes of the vases, which have generally the base showing north polarity, and the mouth showing south polarity. The following conclusions are formulated: (*a*) At the neolithic period (Robenhausen) the magnetic inclination was probably strong and northerly in Switzerland. (*b*) During the bronze period (1500–1250 B.C.), this condition was continued. (*c*) During the epoch 800–600 B.C. the inclination was strong and southerly in Bavaria, this view being in opposition to that given by Folgheraiter. C. P. B.

1537. *Zodiacal Light.* **M. Hall.** (Monthly Weather Rev. 34. pp. 126–131, March, 1906.)—Observations have been made by the author at Kempshott, Jamaica, for the last 30 years, to determine the breadth of the Zodiacal light at various angular distances from the sun. At various times the light was examined spectroscopically, and found to contain no bright or dark lines; the continuous spectrum seen was practically coincident with the brightest part of the solar spectrum, and appeared identical with the spectrum of twilight. After tabulating and plotting the observed breadths, it was noticed that instead of the light being bounded by straight lines from the horizon upward, the boundaries were considerably curved. If the latitudes of various points along the axis of the light be grouped according to their longitudes or distances from the first point of Aries, the symmetry thereby indicated is not with the ecliptic but the invariable plane of the solar system, throughout which was probably scattered all the matter subsequently condensed into the sun and planets. Inclination of this plane for 1900 is 1° 35′ 2″; and the longitude of its ascending node is 106° 52′ 37″. There is some discordance about longitude 238°, but it is thought that this may be due to the influence of the planet Venus. The author concludes that the evidence suggests the existence of such a large quantity of meteoric matter as to permit of the reflection of the sun's light. C. P. B.

1538. *Sun-spot Lines in the Spectra of Red Stars.* **G. E. Hale** and **W. S. Adams.** (Astrophys. Journ. 23. pp. 400–405, June, 1906. Contribution from the Solar Observatory, No. 8.)—Special photographs of the spectrum of α Orionis (third type) were taken with the Snow telescope, employing one prism of 64° angle, with an exposure time of about 7 hours. In the discussion of the lines measured it is shown that there is an almost constant rise of intensity in the lines of V, Ti, Mn, when passing from sun-spot spectra to the spectrum of α Orionis. A table of the lines, with intensities and probable origins, shows very strong evidence of the general agreement between the two spectra. In the region covered, $\lambda 5393$ to $\lambda 5704$, there are but four spot lines of intensity greater than 1–2 on Rowland's scale that have not been measured in α Orionis, and these are all present but are too diffuse for measurement. [See Abstracts Nos. 490, 677, 1025 (1906).] C. P. B.

1539. *System of Castor.* **H. D. Curtis.** (Astrophys. Journ. 23. pp. 351–369, June, 1906.)—The elements of this multiple star have been determined from photographs taken with the Mills spectrograph of the Lick Observatory. Both components are of the Sirian type, catalogued in the Harvard classification as A and VIIIa. The most useful exposures were found to be 18 and 44 min. for the brighter and fainter components respectively, and the measured wave-lengths extend from 4367·8 to 4629·5. The deduced elements are given for each component, with a short discussion of the application of these results to the determinatian of the parallax, masses, and other physical constants of this unique quadruple system. C. P. B.

REFERENCES.

1540. *Effect of Low Temperature on Recovery of Steel from Overstrain.* **E. J. McCaustland.** (Amer. Inst. Mining Engineers, Bull. 10. pp. 621–627, July, 1906.)—Gives the curves representing the results referred to in Abstract No. 1176 (1906). F. R.

1541. *New Hydraulic Experiment.* **A. F. Nagle.** (Amer. Soc. Mech. Engin., Trans. 26. pp. 274–281; Discussion, pp. 281–289, 1905. Presented Dec., 1904.)—The experiments described refer to the determination of the rise of the water in a standpipe, having a long supply pipe, when the draught suddenly ceases. The author tries to find out whether it is possible to deduce a formula based upon experimental data; a formula which will give results fitting all the experiments noted is difficult to construct. The experiments were carried out to set at rest a preconceived notion that under no conditions could the water rise above its original level in the reservoir. The results of the experiments and the application of the formula worked out are given in the paper. L. G.

1542. *Cosmical Corpuscular Radiation.* **C. Barus.** (Science, 23. pp. 952–954, June 22, 1906.)—An account of an attempt to detect ultra-mundane radiation by the condensation and coronal method. Maxima and minima of nucleation occur, and the observations tend generally to confirm the opinion of A. Wood and N. R. Campbell, that the existence of cosmical radiation is evidenced by the occurrence of a daily period of the same [see Abstract No. 1097 (1906)]. J. J. S.

1543. *Distribution of Storms in Italy according to Season.* **V. Monti.** (Accad. Lincei, Atti, 15. pp. 173–175, Feb. 4, 1906.)—The mean number of storms in 5 weeks is plotted against the middle week for various parts of Italy. The author finds the maximum in June for some localities and in August for others; but the characteristics of the curves are not sufficiently definite to draw conclusions from them. S. G. S.

1544. *Structure of Hailstones.* **E. S. Webster.** (Monthly Weather Rev. 34. p. 109, March, 1906.)—The author melted hailstones, up to 1⅝ in. in diam., in clear water or in soapsuds; none of the stones gave an air-bubble in melting. The Editor invites further observations. H. B.

1545. *Monthly Repetition of Earth-tremors.* **F. de Montessus de Ballore.** (Comptes Rendus, 143. pp. 146–147, July 9, 1906.)—The author presents a few notes suggesting that the supposed seasonal periodicity of earth tremors is not real. C. P. B.

1546. *Secular Perturbations of Mars in Motion of Eros.* **W. Dziewulski.** (Acad. Sci. Cracovie, Bull. 10. pp. 811–887, Dec., 1905.)—The paper is a long analytical discussion of the variations produced in the orbit of Eros by the secular perturbations of Mars. C. P. B.

1547. *Stars with Variable Radial Velocities.* **E. B. Frost.** (Astrophys. Journ. 23. pp. 264–269, April, 1906.)—Discussions of the reductions of four stellar spectra which show indications of variable radial velocity. BD. −1°·1004; 29 Canis Majoris; μ Orionis; T Monocerotis. C. P. B.

1548. *Luminosity of the Brightest Stars.* **G. C. Comstock.** (Astrophys. Journ. 23. pp. 248–254, April, 1906.)—An examination of the evidence adduced by Gill, Kapteyn, and Newcomb for considering that several special stars have intrinsic brilliancy of extraordinary degree. C. P. B.

1549. *Solar Research without Eclipses.* **H. Deslandres.** (Comptes Rendus, 142. pp. 1009–1014, May 7, 1906.)—A specially designed instrument is described for attempting to photograph those parts of the solar envelopes which emit continuous radiation, the corona and certain of the prominences. A large concave mirror will be used for giving the primary image, and a smaller one, perforated to allow the bright solar disc to pass through, for reflecting the border of the sun to the photographic apparatus. [See Abstract No. 855 (1906).] C. P. B.

1550. *Figure of the Sun.* **L. Ambronn.** (Astrophys. Journ. 23. pp. 343–344, May, 1906.)—The measurements of the sun's diam. with the Göttingen heliometer made by the author, have been utilised by C. L. Poor for a discussion of the possible variation of the sun's polar and equatorial diameters [see Abstract No. 675 (1906)]. In this note the author severely criticises the conclusions drawn by Poor, stating that the most thorough investigation of the large amount of data accumulated has failed to produce any evidence to indicate a periodicity in the sun's deformation. C. P. B.

1551. *Temperature and Figure of the Sun.* **W. Wundt.** (Phys. Zeitschr. 7. pp. 384–387 and 387–390, June 1, 1906.)—Discussion of the various investigations of solar temperature, with conclusion that probable value is 6,000–7,000° abs. [see Abstract No. 2111 (1904)]. In the second paper the author discusses the refraction theory of Schmidt for explaining the sharpness of the sun's limb in connection with the more recent estimates of the solar temperature. [See Abstracts Nos. 1340 (1903); 67, 270, 1370, 1371, 1375 (1904).] C. P. B.

1552. *Solar Prominences during* 1905. **Mascari.** (Mem. della Soc. Spettroscopisti Ital. 35. No. 4. Nature, 74. p. 65, May 17, 1906. Abstract.)—The paper contains the usual annual summary of the observations of prominences made at Catania during 1905. The mean daily frequency of prominences was greater than during 1904 and 1903, with a decrease of heliographic latitude. The mean altitude of the prominences was 43·7″ in 1904, and 44·1″ during 1905. Much greater frequency was exhibited in the sun's northern hemisphere. C. P. B.

1553. *Stars with Peculiar Spectra.* **N. Lockyer** and **F. E. Baxandall.** (Roy. Soc., Proc. Ser. A. 77. pp. 550–553, June 21, 1906.)—In the investigation dealing with classification of stellar spectra certain stars were found to have peculiar spectra in that, although their general features conformed in general with recognised types, there were superposed other details which were not characteristic of the group. The chief of these stars were α Andromedæ, θ Aurigæ, α Canum Venaticorum, and ε Ursæ Majoris. They are all on the descending side of the Kensington curve of stellar temperature, the first three being of the Markabian type and the last of the Sirian type. C. P. B.

1554. *Brightness of Nova Aquilæ No.* 2. **Guthnick.** (Astronom. Nachr. No. 4098. Nature, 74. p. 253, July 12, 1906. Abstract.)—The author analyses a series of seventy-seven observations of Nova Aquilæ (No. 2) made at the Bothkamp Observatory between Sept. 5 and Dec. 10, 1905. The light curve was found to be parabolic. C. P. B.

1555. *Star Transits by Photography.* **S. Hirayama.** (Nature, 74. pp. 254–255, July 12, 1906. From Annales de l'Observatoire astronomique de Tokyo, Tome 3, fasc. 4.)—Description in detail of a photographic transit telescope, aperture 13·5 cm., focal length 211 cm. As an indication of its efficiency it is stated that with a full second's exposure equatorial stars of the fifth magnitude gave a measurable image. The exposing apparatus is of the rocking-bar type. The probable error from a single pair of measures is ± 0·017 sec., and the mean error of a complete transit observation of 32 pairs is ± 0·002 sec. There appears to be an error depending on the definition of the image, which is affected by the altitude of the star. C. P. B.

LIGHT.

1556. *Optical Device for Generalising the Use of a Large Reflector.* **G. Millochau.** (Comptes Rendus, 143. pp. 33–35, July 2, 1906.)—The Meudon reflector with an aperture of 1 m. and focal length 3 m. gives great concentration of light, but hitherto, for purposes where a pencil of angle less than 1/3 is indispensable, it has been necessary to employ a diaphragm, thus wasting the light-grasping power of the mirror. The author has devised a lens combination by means of which the focal length of the telescope can be greatly extended, so as to give a small-angle pencil without employing a diaphragm. The principle is based on the fact that, in a system of lenses or mirrors, the algebraic sum of the angular aperatures of the incident and emergent pencils and of the lenses or mirrors is zero, a relation immediately deduced from the formula $1/p + 1/p_1 = 1/f$. A compound lens, consisting of three equal concave lenses, each of angular aperture 1/10, is placed between the mirror and its focus, so as to produce a real enlarged image, the pencil of angle 1/3 proceeding from the mirror being thus transformed to one of angle 1/30. The rays from the large mirror fall first on the small silvered plane mirror (the reflector being of the Newtonian variety), which reflects them into the lens triplet, whose components are achromatised from C to *h*. The image obtained being near the axis of the telescope, a positive objective is employed to throw this image outside the tube, where it can either be observed with an eyepiece or photographed. By varying the position of the lenses, images are obtained having the dimensions which would be given by a mirror of 1 m. diam. and a focal distance varying from 15 to 25 m. Photographs of Jupiter and the moon taken by these means were comparable to those obtained with the great Meudon refractor. It will now be possible to use a spectroscope of ordinary dimensions in combination with the 1-m. reflector, utilising all the light reflected by the great mirror. A different optical arrangement based on the same principle, but with convex lenses, might be used to serve as a collimator for bringing the rays of the pencil of angle 1/3 to parallelism. With four lenses of angular aperture 1/12, such a collimator could be constructed, having an equivalent focal length only equal to that of the fourth lens. For instance, four equal lenses of 200 mm. focus might be employed to form a collimator of 200 mm. apparent focus, the nodal plane of the first lens being placed 50 mm. from the slit. A. E.

1557. *Heliometer by Reflection.* **M. Štefánik.** (Comptes Rendus, 143. pp. 106–107, July 9, 1906.)—In the heliometer of ordinary form, the rays have to pass through a considerable thickness of glass—a fact which gives rise to serious inconvenience when the image to be doubled is of large diameter. The author suggests that two images should be produced by interposing two inclined movable mirrors between the objective and its focus, and so dividing the luminous pencil. The arrangement might be of service in spectroscopic measurement of velocity in the line of sight, since it enables the images of two objects, or two parts of an object, to be placed in contact on the slit. Their spectra can then be directly compared, line for line. For instance, it might be applied to measure the rotation of the sun or planets. The instrument might also be used for photometry, since by displacing the system of mirrors through a measured amount perpendicular to the optic axis, the intensity of the two images can be varied. If there are two stars in the field, for example, producing four images, then by adjusting the mirrors, the brighter image of one pair may be made equal to the fainter of the other pair. A. E.

1558. *General Determination of the Optical Constants of a Crystal by Means of Refraction through a Prism.* **G. F. H. Smith.** (Phil. Mag. 11. pp. 29-36, July, 1906.)—The optical constants are generally determinable by refraction through a prism formed by a pair of natural or artificial faces on the crystal, inclined to one another at not too large an angle. It is often the case, however, that in natural crystals advantage cannot be taken of this simple method; the crystal may not have suitable natural faces inclined at a small enough angle, and may be so small itself that artificial faces cannot be ground on to it. It is shown, however, that even in such cases it is possible, by taking observations sufficiently far round a zone, to determine the optical constants. J. W. P.

1559. *Interference Colours of Chlorate of Potash Crystals.* **R. W. Wood.** (Phil. Mag. 12. pp. 67-70, July, 1906.)—Thin flakes of crystals of potassium chlorate have the remarkable property of reflecting all of the incident light of a certain colour or colours, while freely transmitting the remainder of the spectrum. The reflected colours are of great spectral purity, the width of the band being sometimes not greater than the distance between the yellow mercury lines. The spectrum of the transmitted light will often be found to be crossed by one or more intensely black narrow bands. The present paper considers the behaviour of the crystals in the infra-red and ultra-violet regions. Two or three narrow bands in the visible spectrum are reflected by many crystals, and the colours may be referred to different orders. The crystals were examined by mounting the films placed in glycerine between two quartz prisms in front of the slit of a small quartz spectrograph, and orienting the films so as to throw the light from a cadmium spark into the instrument. A series of photographs obtained in this way are given. In some cases a number of bands appear in the ultra-violet, and in other cases only one or two. J. J. S.

1560. *Colour Phenomena in Photometry.* **J. S. Dow.** (Phil. Mag. 12. pp. 120-134, Aug., 1906. Communicated by the Physical Soc. Electrician, 57. pp. 747-750, Aug. 24, 1906.)—Experiments were carried out to find to what extent ordinary photometric measurements are affected by errors due to the fact that the two sources of light compared in everyday work are rarely of the same colour. The Lummer-Brodhun, the Grease-spot, the Joly, and the Flicker photometers were used in these experiments. The uncertainties which may be introduced by colour phenomena appear to be due to four separate effects: (1) The difficulty of obtaining a balance with differently coloured lights, and the possibility that the judgments of different people may not be the same. An experienced photometrist often obtains extraordinarily consistent results, even when comparing ruby-red light with green light, but if he allows his eye to rest for an hour or so, the new readings may be 5 or even 10 per cent. different from the old readings. The suggestion is made that extreme consistency is due merely to visual memory. (2) The fact that the apparent relative brightness of two surfaces, illuminated by lights of different colour, depends on the part of the retina on which the image falls. This effect has been completely dealt with by Abney. The author's experiments show that not only do the figures obtained when comparing, for instance, red with green light, differ enormously with the distance of the eye from the photometer disc, but they also differ with the kind of photometer used. A difference of nearly 1 per cent. was obtained between the readings with the telescope, in the two extreme positions, the disc being practically in focus in each case, when comparing a Fleming standard glow-lamp with a pentane lamp by a Lummer-Brodhun photometer. When the lights compared differ in colour, it is pointed out that the Lummer-Brodhun photometer behaves differently to the Joly or the Grease-spot photometer. In the latter the image is practically the same on reversing, but in the former it is different. For instance, if we have a green disc with a red centre, then after reversal we have a red disc with a green centre. The following figures, giving the percentage difference in the two cases, illustrate this:—

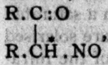
Photometers.	Lights of Similar Colour.	Red to Green Light.
Joly...........................	2	5·5
Grease-spot	3	6·0
Lummer-Brodhun	4	18·0

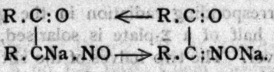
(3) The Purkinje phenomena. This is only troublesome at very low illuminations, and thus introduces no error in practical photometry. (4) The possibility, when mirrors are used, that the coefficient of reflection may not be the same for different coloured lights. Experiments were made with red and green lights, and the numbers found for the coefficient in the two cases were practically the same. An investigation is made to find out how far flicker photometers are affected by errors due to differences of colour, and it is concluded that they are affected by the same colour phenomena. The question is raised as to whether a colour-blind person would obtain the same results as a person with normal vision when comparing a red and a green light with a photometer. It is pointed out that there are two kinds of colour-blindness. In the first kind a red object appears luminous to the eye, but in the second kind the eye is incapable of seeing red light at all. A person having the first kind of colour-blindness would presumably make normal readings, but a person having the second kind would make abnormal readings. A. R.

1561. *Silver Bromide-Gelatine containing a Developer.* **J. Precht** and **E. Stenger.** (Zeitschr. Wiss. Phot. 3. pp. 76–80, 1905.)—Solarisation is strongly retarded by the presence of reducing agents, and the treatment of ordinary photographic plates with a 1 per cent. solution of a developer before exposing them is hence advised. Tests have shown that a 44 times more intense illumination is required to produce solarisation in such treated plates, as compared with ordinary plates. L. H. W.

1562. *Polarisation and Selective Reflection in the Infra-Red Spectrum.* **A. H. Pfund.** (Astrophys. Journ. 24. pp. 19–41, July, 1906.)—The investigation was undertaken with the object of collecting data, by means of which some insight might be obtained into the actual mechanism of reflection. In the course of the work a new polariser and analyser were discovered, which are believed to be an improvement upon forms now in use. Such polarising devices as Nicol or Rochon prisms fail beyond 2·5 μ in the infra-red, on account of the opacity of the Iceland spar used in their construction. In employing the method involving reflection at the polarising angle from some transparent substance, glass has frequently been used in the infra-red as a polariser. The author proves that glass is unfit for the purpose (the curve of reflecting power rising abruptly to a maximum between 7½ μ and 13 μ), as might have been predicted from the fact that it contains SiO_2, which gives rise to the bands of metallic reflection of quartz. The results of his investigations are summed up by the author as follows: (1) The reflecting power of amorphous selenium has been studied out to 13 μ. In consequence of its high and constant reflecting power, this substance was used in the construction of a polariser and analyser adapted for work throughout the infra-red spectrum. (2) It was shown that infra-red radiations are capable of being polarised out to a wave-length of 13 μ, which was as far as the experiments could be carried. (3) It was shown that the non-metallic substance, Iceland spar, in its region of metallic reflection transforms plane into elliptically polarised light by reflection. This shows that, so far as its behaviour toward plane polarised light is concerned, there is nothing to distinguish a non-metal from a metal. (4) Upon finding that the positions of the bands of selective reflection from a solid salt (Na-K tartrate) remain unchanged when the salt is molten, it is concluded that the mechanism giving rise to these bands is not affected by the freedom of motion of the molecule as a whole, and is therefore in all probability localised within the molecule itself. (5) By examining numerous liquids it was found that these, as well as the solids, possess bands of selective reflection in the infra-red. (6) In the case of fuming sulphuric acid it was found that marked changes in the reflection-curves appeared when the acid was diluted. It was concluded that these changes were due to the breaking-down of certain compounds in solution and the consequent formation of new ones. (7) From the marked similarity in appearance and position of reflection maxima of the salts of a given acid (nitrates and sulphates) it was concluded that the mechanism giving rise to these maxima was localised within the acid radical. *Minute Concave Mirrors.*—The author mentions a method of obtaining small concave mirrors weighing a milligramme or two. A small concave mirror or good spectacle lens, of about 1 m. radius of curvature, is heavily silvered and polished on its concave side, and is then cut up into strips about 4 mm. wide. If, now, one of these strips be struck a smart tap on its edge with a flat file, small scales of glass bearing silver on one side can be caused to fly off, and they are the mirrors in question.

A. E.

1563. *Relation between Absorption Spectra and Chemical Constitution. V. The Isonitroso-compounds.* **E. C. C. Baly, E. G. Marsden,** and **A. W. Stewart.** (Chem. Soc., Journ. 89. pp. 966–982, June, 1906.) *VI. The Phenyl Hydrazones of Simple Aldehydes and Ketones.* **E. C. C. Baly** and **W. B. Tuck.** (Ibid. pp. 982–998.)—V. It has been shown in previous papers that when two carbonyl groups are adjacent to one another in a compound, the process of isorropesis is set up between the residual affinities of the oxygen atoms, with the result that an absorption band is produced in the visible blue region of the spectrum, and the compounds are coloured. The principle has already been extended to the quinones and to the nitrophenols and nitroanilines. In the present paper the isonitroso-compounds are dealt with, and the yellow colour in alkaline solution is explained. From observations of the absorption spectra of several isonitroso-compounds in neutral and alkaline solution, it is found that the free substances most probably have the constitution  $\begin{array}{l}R.C:O\\ \;\,|\\ R.\overset{*}{C}H.NO\end{array}$, but in presence of sodium hydroxide the hydrogen atom marked with a star is replaced by sodium and becomes labile, so that a tautomeric process occurs, thus—



$$\begin{array}{lcl}R.C:O & \longleftarrow & R.C:O\\ \quad\;| & & \quad\;|\\ R.CNa.NO & \longrightarrow & R.C:NONa.\end{array}$$

Isorropesis then takes place between the $>C:O$ and $>C:N$-groups, the tautomeric process being the actuating mechanism. The compounds are therefore yellow in alkaline solution owing to the presence of an absorption band in the visible blue region of the spectrum, which is due to isorropesis. VI. A spectroscopic investigation of the phenylhydrazones of formaldehyde, acetaldehyde, propylaldehyde, acetone, and diethylketone shows that all these compounds exist in two forms, the true hydrazone and the azo form; in the latter the hydrogen atom has wandered from the nitrogen atom to the carbon atom of the aldehyde or ketone residue, thus—

$$Ph.NH.N:CH.CH_3 \text{ and } Ph.N:N.CH_2.CH_3.$$

The azo form is the more stable, and all the above compounds readily pass over into this form under the influence of light, except formaldehyde phenylhydrazone, which polymerises. All the azo compounds are strongly coloured owing to the isorropesis between the unsaturated nitrogen atoms and the benzene nucleus. An investigation into the absorption spectra of the hydrazones of the three isomeric nitrobenzaldehydes shows that the colour of these substances is not due to their existence in the azo form. It is found, however, that they exist in the quinonoid form, and are somewhat similar to the nitrophenols. [See also Abstract No. 1246 (1906).] D. H. J.

1564. *Spectrum of Iron. Contribution towards the Establishment of a Spectroscopic Standard.* **C. Fabry** and **H. Buisson.** (Comptes Rendus, 143. pp. 165–167, July 16, 1906.)—Fabry and Perot have already established a new interference standard of wave-lengths which has been adopted by spectroscopists, but in order to bring the standard into general use it is necessary to measure a series of lines, each of which should be within 50 A.U. of its neighbour, the series extending from $\lambda = 7000$ to $\lambda = 2000$. The present paper contains the first step towards this ideal; the authors give the wave-lengths of 84 lines between $\lambda = 6495$ and $\lambda = 3607$. They are all in the arc spectrum of iron with the exception of four nickel lines, which were measured to fill a gap in the iron spectrum; there is also one manganese line due to impurity. The method of measurement was exactly the same as that of Fabry and Perot, with the exception that photography of the fringes was substituted for eye observation. The error is less than 1 in 1,000,000. E. C. C. B.

1565. *Preliminary Measures oj the Infra-Red Lines of the Solar Spectrum.* **G. Millochau.** (Comptes Rendus, 143. pp. 108–110, July 9, 1906.)—The author has described in a former note his method of photographing the infrared spectrum by means of a red screen and solarised plates, the employment of plates coloured with chrysoïdine being recommended [see Abstract No. 1376 (1906)]. Since then, erythrosine has also been found to give excellent results as a red colouring material, while eosine renders the plates sensitive as far as Z, but is not favourable for photography from A to π. The plates (Lumière Σ) are first immersed in water for 15 min., then in a saturated alcoholic solution of the dye. After drying in the dark-room they are solarised by artificial light, and are then ready to receive the impression of the infra-red rays. The wave-lengths are determined by the method employed by Hasselberg for the ultra-violet, which consists in directly comparing each radiation with the corresponding radiation in the grating spectrum of a different order. Only half of a Σ-plate is solarised, the other half being masked by a metal cover. The two halves of the slit are covered in succession, and the infra-red spectrum of the first order photographed on the solarised half-plate (with screen), and the blue and violet spectrum of the second order on the other half-plate (without screen). The wave-lengths and intensities of 106 lines ranging from λ 8025 to λ 9325 are tabulated. The values for a few of the stronger lines are here quoted—

	Intensity.	λ (Ångstrom).		Intensity.	λ (Ångstrom).
Z	9	8226·7	X_3	6	8663·0
X_1	5	8498·2	π	9 9	8988·2 8991·7
X_2	7	8543·1	—	5	9325·2

The wave-length for Z is approximate, the line consisting of a very short, intense band shading off towards the infra-red. A. E.

1566. *Nitrogen Spectrum in a Magnetic Field.* **N. Vaccaro.** (N. Cimento, 11. pp. 222–226, April, 1906.)—The author has repeated the experiments of Zonta [see Abstract No. 2882 (1904)], taking care to determine in each case the pressure in the vacuum tube. He has succeeded in explaining why the magnetic effect on the brightness of the lines was noticed by Zonta and not by Preston. There is no effect at a "critical" pressure of 0·5 mm. At all higher pressures the spectrum of rarefied air increases in brightness and richness of bands in a magnetic field, while the reverse is the case at lower pressures. E. E. F.

1567. *Influence of Electric Fields on Spectral Lines: Preliminary Note.* **G. F. Hull.** (Roy. Soc., Proc. Ser. A. 78. pp. 80–81, July 21, 1906.)—The electric fields were those actually produced by the discharge which was being examined; a Michelson interferometer and an echelon grating were employed. It was found that no effect was produced (1) by reversing the direction of the discharge, (2) by the passage of Röntgen rays through the discharge tube, or (3) by turning the discharge tube through an angle of 90°. This shows that the curvature of the lines as obtained by Schuster and Hemsalech with a rotating mirror was not due to motion of the luminous particles. Doppler-effects in the canal rays were found for the strong hydrogen lines; this was first noticed by Stark. No polarisation was observed in the light from a canal-ray tube. The light from the discharge in tubes 3 to 4 cm. in diam. was examined perpendicular to the direction of the discharge at various points between the electrodes and also behind the perforated kathode. The principal hydrogen lines were greatly broadened (0·4 A.U.) in those parts where the electric field is known to be of great intensity; this broadening appears to be due to motion of the luminous particles. E. C. C. B.

1568. *Phosphorescent Spectra of Terbium and Dysprosium.* **G. Urbain.** (Comptes Rendus, 143. pp. 229–231, July 23, 1906. Chem. News, 94. pp. 79–80, Aug. 17, 1906.)—The author finds that the three rare elements, terbium, dysprosium, and neo-holmium do not phosphoresce when submitted in the state of oxide to the kathode streams. When, however, the first two oxides are diluted with about 99 parts of lime they give a well-marked phosphorescence. The wave-lengths of the lines are given. [See also Abstract No. 1233 (1906).] E. C. C. B.

1569. *Pyroluminescence of Quartz.* **V. M. Goldschmidt.** (Vid.-Selsk. Forh., Christiania, No. 5. pp. 1–9, 1906. Chem. Centralblatt, 1. p. 1372, 1906.)—The pyroluminescence of quartz depends neither on the colour, odour, nor the nature of the surrounding medium. Commencing at 150° it is most distinct about 250°, is not affected by powdering the quartz, but is destroyed by heating at 400°. The luminescence is apparently phosphorescence which is accelerated by heat, since, although it cannot be excited by sunlight, electric sparks, or Röntgen rays, it is produced or regenerated by the radiation of radium compounds. The colour is not affected by the radiation in the latter case, but when quartz from Fevor was exposed to the action of kathode rays, it became at first slightly brown and fluorescent, then phosphoresced for a short time, and finally showed long-sustained pyroluminescence at 320°. L. H. W.

1570. *Theory of Fluorescence.* **G. Woker.** (Journ. Phys. Chem. 10. pp. 370–391, May, 1906. From the German.)—The fluorescence of a coloured compound may be completely masked if the fluorescent light (*e.g.*, blue or violet) is complementary to the colour of the solution (*e.g.*, yellowish-orange). Thus the fluorescence of quinine sulphate disappears on adding picric acid, and that of petroleum on adding methyl orange. The violet fluorescence of pure chrysene is entirely masked by the yellow colour of an impurity which is very difficult to remove, and the yellow solution of anthracene in sulphuric acid shows no trace of the blue anthracene fluorescence. The introduction of chromophoric groups into a compound usually decreases the visible fluorescence (1) because it frequently produces a colour complementary to that of the fluorescent light, (2) because it displaces the chromophores towards the red, thus decreasing the likelihood of fluorescence. Nitro-groups are particularly effective in checking fluorescence, possibly because their yellow colour masks the blue fluorescence. Again, it is frequently observed that whilst coloured dye-stuffs have no fluorescence, the leuco-compounds (in which the chromophores have been eliminated by reduction) are frequently fluorescent. Benzene and its derivatives possess a very marked "latent fluorescence," *i.e.*, the rays absorbed are in the extreme ultra-violet and the fluorescence is also in the ultra-violet. This fluorescence may be rendered visible if its period is reduced (1) by using solvents of high dispersive power, (2) by the introduction of chromophores or batho-chrome salt-forming groups, which in other cases reduce fluorescence by transferring it from the visible to the infra-red spectrum, (3) by uniting together two or more phenyl nuclei in positions which specially favour fluorescence. T. M. L.

1571. *Phosphorescence of Zinc Sulphide.* **W. P. Jorissen** and **W. E. Ringer.** (Chem. Centralblatt, 1. p. 644, 1906. From Congrès Chim., Liége, Pub., 1905.)—Only in the presence of traces of foreign matter do the pure sulphides of Ca, Ba, or Zn phosphoresce. The chlorides of Na or K, and salts of Bi, Cd, or Mn produce the most marked effect, in the case of zinc sulphide; magnesium chloride or sulphate have no action. The addition of Mn salts increases, of Cu salts diminishes, and of Pt and Ag salts completely suppresses, the phosphorescence caused by the chlorides of Na or K.

L. H. W.

1572. *Phosphorescence of Nitrogen and Sodium.* **K. v. Mosengeil.** (Ann. d. Physik, 20. 4. pp. 833–836, July 20, 1906.)—The author has repeated P. Lewis's experiments upon the phosphorescence of nitrogen when submitted to condenser discharge under reduced pressure. Lewis found that if the final traces of oxygen were removed by sodium the nitrogen no longer showed the phosphorescent effect. The author finds, however, that if the nitrogen be purified over sodium and then admitted into the vacuum tube, the phosphorescence is not diminished. It is only when the sodium is introduced into the vacuum tube that the phosphorescence is stopped. It is also noticed that sodium vapour itself shows phosphorescence under similar conditions. [See Abstracts Nos. 1337, 1338, 1344 (1904).]

E. C. C. B.

1573. *Radio-activity of Gas from Thermal Springs.* **P. Curie** and **A. Laborde.** (Comptes Rendus, 142. pp. 1462–1465, June 25, 1906.)—The waters examined contained a radio-active emanation but no radium salts, and entirely lost their activity when stored for a month. The radio-activities were determined 4 days after the samples were taken, and probably amounted to about one-half of the initial values. The emanation remaining in 10 litres of water corresponded in the highest instance to that liberated by 1 mgm. of radium bromide in 0·46 min. The gas from the springs was also examined, and its radio-activity compared with that of 10 litres of air rendered active by contact with 1 mgm. of radium bromide; in a single case the radio-activity of the natural gas (from an Austrian spring) was equal to that of air exposed to the action of radium bromide during 40 min., but in no other case did the value exceed that produced by 6 minutes' exposure. T. M. L.

1574. *Radium and Uranium in Minerals.* **E. Rutherford** and **B. B. Boltwood.** (Amer. Journ. Sci. 22. pp. 1–3, July, 1906.)—In a previous paper [Abstract No. 1587 (1905)] it has been found that $7{\cdot}4 \times 10^{-7}$ gm. of radium corresponds to 1 gm. of uranium in minerals. Later work has shown that the radium standard is not constant, and a revision of the work was necessary [see next Abstract]. The revised number is $3{\cdot}4 \times 10^{-7}$ gm. of radium per gm. of uranium. R. S. W.

1575. *Radium in Minerals.* **A. S. Eve.** (Amer. Journ. Sci. 22. pp. 4–7, July, 1906.)—The author has previously shown [Abstract No. 896 (1906)] that the γ-radiations from radium, thorium, and radio-thorium are similar in character and equally absorbed by lead, and that it is possible to find the amount of these substances in a mineral by cutting off the easily absorbed Ur and Ac γ-rays, and comparing the remaining γ-radiation with that from a known weight of radium. He has used this method, but found it did not give results that were concordant with those obtained by the emanation method [see preceding Abstract]. This has been traced to the inconstancy of the standard radium solution used in the latter method. It is found that half of the salt has come out of solution. This can be prevented by the addition of HCl. With a new standard, Boltwood's results [see preceding Abstract], obtained by the emanation method [see Abstract No. 1587 (1905)], agree with those of Eve by the γ-ray method. Incidentally it is found that radium E gives out no γ-rays or else rays that are easily absorbed. R. S. W.

1576. *Periods of Transformation of Radium A, B, and C.* **H. L. Bronson.** (Phil. Mag. 12. pp. 73–82, July, 1906.)—Experiments were made to determine whether or not radium A was the parent of radium B. Careful observations were made on the rate of decay of the products A, B, and C, and the results are expressed in curves and tables. The analysis of the decay curves of the active deposit from radium shows: (1) That within the limits of experimental error the experimental decay curves agree with the theoretical decay curves, calculated on the assumptions that the three products A, B, and C. are successive, and that their periods are respectively 3, 26, and 19 min. (2) That radium B, as stated by Schmidt, emits β-rays of less penetrating power than those of radium C, and that on this account the β-ray decay curves are unsatisfactory for purposes of analysis. (3) That these β-rays from radium B completely explain the divergence which Rutherford found between the experimental and theoretical β-ray curves. J. J. S.

1577. *Properties of the α-Rays of Radio-Thorium.* II. **O. Hahn.** (Phil. Mag. 12. pp. 82–93, July, 1906. Phys. Zeitschr. 7. pp. 456–462, July 1, 1906.)—This paper deals with the ionisation ranges of the α-ray products of thorium, viz., radio-thorium, thorium X, and the emanation. The method used (excepting in the case of thorium emanation) was very similar to that employed by Bragg and Kleeman for the different radium products. The results obtained, together with those published in a former paper, are summarised in the following table, which gives the ranges of the α-particles from the five α-ray products of thorium. For comparison the ranges of the α-particles from the radium products determined by Bragg and Kleeman are also added :—

Product.	Range of the α-particles (in cm.) in air at atmospheric pressure and temp.	Product.	Range of the α-particles.
Thorium	rayless	Radium	3·50 cm.
Radio-thorium	3·9 cm.	Emanation	4·23 „
Thorium X	5·7 „	Radium A	4·83 „
Emanation	5·5 „	„ B	only β-rays
Thorium A	rayless	„ C	7·06 cm.
„ B	5·0 cm.	„ D	rayless
„ C	8·6 cm.	„ E	only β-rays
		„ F	3·86 cm.

The results obtained are in harmony with the theory of absorption of the α-rays advanced by Bragg and Kleeman. The α-rays emitted by any single α-product all travel at the same speed, and cease ionising the gas fairly suddenly after passing through a definite thickness of air. The α-particles from the different products differ only in the speed of projection, which determines the range of the ionisation of the α-particles in air. If it is assumed that the

α-particles emitted by the thorium and radium are identical in all respects, the results show that the α-particles from the thorium products are, on the average, projected with greater velocity than the α-particles from the radium products. In each case the velocity of the α-particles from the corresponding products, radium C and thorium C, is much greater than that of the α-particles from the other products. [See also Abstract No. 1237 (1906.)] J. J. S.

1578. *Relation between Radio-activity and Composition of Thorium Compounds.* **H. N. McCoy** and **W. H. Ross.** (Amer. Journ. Sci. 21. pp. 433–443, June, 1906.)—The activity of the emanation of a film of a thorium compound placed in a small closed space, such as an electroscope case, increases with time and reaches a maximum in about 5 min., owing to the accumulation of the evolved emanation. It can, however, be shown that the actual activity of the evolved emanation exactly compensates for the deficiency of activity of the solid film, so that the observed activity of a very thin film of a thorium compound is equal to the true activity. This relation holds very closely for films of strongly-ignited thorium dioxide up to about 0·005 gm. per sq. cm. The authors give a method for arriving at the true activity of a thick film. The activities of orangeite, thorite, and monazite are proportional to their contents of ThO_2, the activity of the uranium present being allowed for. The same is the case with preparations of thorium dioxide separated during analysis of the minerals. None of the radio-thorium is hence separated from the thorium by the processes of analysis. It is, however, possible, by certain processes many times repeated, to reduce considerably the permanent activity of thorium, presumably by the removal of part of the radio-thorium. T. H. P.

1579. *Range of α-rays from Polonium.* **M. Levin.** (Amer. Journ. Sci. 22. pp. 8–12, July, 1906. Phys. Zeitschr. 7. pp. 519–521, Aug. 1, 1906. Écl. Électr. 48. pp. 301–303, Aug. 25, 1906.)—Using Bragg's method the range in air is found to be 3·86 cm. Only one kind of α-ray is emitted. R. S. W.

1580. *Radio-activity of Air.* **J. E. Burbank.** (Terrestrial Magnetism, 11. pp. 105–107, June, 1906. Paper read before the Phil. Soc. of Washington, May 19, 1906.)—The rate of decay of the activity on a wire exposed to the air is measured after different lengths of exposure. For an exposure of 3 hours the decay curve is approximately that of radium. For exposures of 27, 41, 22 hours the rate of decay is much slower and is due to thorium. R. S. W.

1581. *Emission of Electricity from Radium Products.* **W. Duane.** (Science, 24. pp. 48–49, July 13, 1906. Abstract of paper read before the Univ. of Colorado, May 5, 1906.)—A report of the results of two series of experiments on the charge carried by the α- and β-rays. A metal wire was made active by immersion in radium emanation, and was then placed inside a small, hard rubber tube with very thin walls. The outside of the tube was surrounded by mercury in metallic contact with the earth, and the wire was connected to a quadrant electrometer. Positive electricity was discharged from the wire for 5 or 6 min., and the electrometer indicated the accumulation of a negative charge. After 10 min. the electrometer indicated the accumulation of a positive charge, and the emission from the wire of negative electricity. This agrees with the accepted views as to the charges carried by the α- and β-rays. Radium A radiates α-rays only, and radium C both α- and β-rays.

Radium A disappears in 10 min., so that the α-rays coming from A and C, passing through the rubber, caused a negative charge to appear on the wire for the first few min. After 10 min. the positive charge was due to the β-rays of radium C, which pass through the rubber more easily than the α-rays. In the second series of experiments a wire was made radio-active as before, and placed inside and coaxial with a metal tube whose diam. was slightly greater than that of the wire. The tube was then sealed up and exhausted to a pressure of about 0·1 mm. of mercury. The wire being connected to the electrometer, and the tube to earth, the electrometer deflections indicated a continual accumulation of a positive charge from the start. Measurements were made of the rate of discharge of negative electricity from the wire, and these showed plainly that the rate was not proportional to the ordinary ionisation effect of the induced activity. The curves are much steeper than those for the rate of decay of the ionisation currents, except for the first 10 min. They agree, approximately, with the theoretical curves of Rutherford, representing the sum of the quantities of radium B and radium C on the wire. From this the author concludes that radium B, hitherto considered non-radio-active, emits, approximately, as much negative electricity as radium C. The ratio of mass to charge was found to be roughly equal to that of the β-rays. The velocity of the carriers is very much smaller than that of the β-rays, and seems to indicate that the carriers are similar to those called by Thomson δ-rays. A. W.

1582. *Action of α-Radiation on Diamonds.* (Nature, 74. p. 271, July 19, 1906.)—The α-radiation which produces the spinthariscope effect when allowed to act on zinc blende, gives with the diamond a continuous fluorescence in which no localised action can be detected. It is suggested that in the former case the fluorescence is propagated through crystalline particles of limited size, whilst in the diamond the disturbance is propagated throughout the mass. The analogy is suggested of a handful of gravel thrown into a collection of small puddles, which when struck become intensely disturbed over a limited area (zinc blende) as compared with gravel thrown into a pond, which becomes disturbed all over the whole surface, though with less intensity (diamond). T. M. L.

REFERENCES.

1583. *Large Quartz Spectrograph.* **P. Lewis.** (Astrophys. Journ. 23. pp. 390–395, June, 1906.)—Description of the large new quartz-train spectrograph built at the University of California for investigations of ultra-violet spectra. The prisms are of the Cornu type, each consisting of two half-prisms of 30° angle, of right and left rotation respectively. The lenses are plano-convex, 9·2 cm. in diam., and 1 m. focal length for sodium light. C. P. B.

1584. *New Forms of Astrographic Object Glasses.* **E. Schaer.** (Astronom. Nachr. No. 4100. Nature, 74. p. 231, July 5, 1906. Abstract.)—A description of the construction of a new short-focus objective, employing two lenses of the usual crown and dense flint glasses. The crown is placed in front of the flint, and the back of the latter silvered. C. P. B.

1585. *Arrangement for Simultaneous Adjustment of Several Prisms in Position of Minimum Deviation.* **P. Lambert.** (Comptes Rendus, 142. pp. 1509–1511, June 25, 1906.) E. C. C. B.

1586. *Objective Prism Spectrograph.* **de Lisle Stewart.** (Astrophys. Journ. 23. pp. 396–399, June, 1906.)—Two prismatic cameras are mounted together with their axes inclined about 15° to each other, giving two spectra in juxtaposition, but in reverse order. Two supplementary lenses of long focus are employed to give a reference trail on the plate and to act as guide during the exposure. It is hoped that by photographing the two spectra simultaneously the usual errors of refraction, changes due to temperature, flexure, &c., may be eliminated. C. P. B.

1587. *Interference Fringes under the Microscope.* **F. E. Wright.** (Amer. Journ. Sci. 22. pp. 19–20, July, 1906.)—A simple method of viewing the interference effects of a conical polarised beam without necessitating the removal of the eyepiece as in the Lasaulx method is described. Two right-angled prisms reflect the beam so that it travels to the eye outside the body of the microscope, and the prisms can be readily slid into or out of action. A convenient arrangement of stops is also described. S. G. S.

1588. *Solution of Problems in Diffraction by the Aid of Contour Integration.* **H. Davies.** (Phil. Mag. 12. pp. 63–67, July, 1906. Communicated by the Physical Soc.)—An analytical treatment of the solution of $\partial^2V/\partial t^2=a^2\nabla^2V$ for the case of a wedge of angle α in which the electric force—taken as the light vector—is parallel to the edge of the wedge. J. W. P.

1589. *Photography of the Infra-red Rays.* **W. Ritz.** (Comptes Rendus, 143. pp. 167–169, July 16, 1906.)—The author has made investigations into the conditions governing the well-known process of Abney for the preparation of an emulsion sensitive to the infra-red rays. He has succeeded in improving the original method and in preparing an emulsion which on exposure to the spectrum of a Nernst lamp, gave an image regularly decreasing in intensity down to as far as $1{\cdot}4\mu$. Technical details will appear elsewhere. E. C. C. B.

1590. *Polarisation at Total Reflection.* **F. Koláček.** (Ann. d. Physik, 20. 3. pp. 433–479, June 26, 1906.)—An elaborate mathematical treatise, on Maxwell's theory, of the polarisation which occurs at the limiting lines on total reflection. The paper concludes by a comparison of the results of the theory with those of experiments on calcspar, carbon disulphide, benzol, and other substances, the agreements being very good. E. H. B.

1591. *Arc Spectra of Neodymium and Praseodymium.* **M. Bertram.** (Zeitschr. Wiss. Phot. 4. pp. 16–43, 1906. Chem. Centralblatt, 1. p. 1321, 1906.)—Preparations of neodymium and praseodymium were introduced into an arc between carbon electrodes and the spectra photographed with the aid of a Rowland grating of 6·6 cm. curvature and 16,000 lines to the inch; the spectrum of iron was photographed on the same plate. The wave-lengths are given in tables in the original. L. H. W.

1592. *Absorption Spectra of Neodymium and Praseodymium.* **W. Rech.** (Zeitschr. Wiss. Phot. 3. pp. 411–428, 1905. Chem. Centralblatt, 1. pp. 734–735, 1906.)—The author employed solutions of the pure oxides of neodymium and praseodymium in HCl so diluted that the absorption spectra showed no bands (1/256-N and 1/512-N respectively); the liquids were in a glass tube with quartz ends, for examining the refrangible portion of the spectrum. The whole spectrum was photographed, employing zirconium light and two Rowland concave gratings of 1 m. curvature and 20,000 lines to the inch. The results are given in tables and are compared with previous measurements. L. H. W.

HEAT.

1593. *Low-resistance Thermo-electric Pyrometer and Compensator.* **W. H. Bristol.** (Amer. Soc. Mech. Engin., Trans. vol. 27, 1906. Elect. Rev., N.Y. 48. pp. 732–734, May 12, 1906. Abstract.)—The chief feature consists in the employment of thermo-couples of alloys of tungsten, steel, nickel, iron, and copper, according to the range of temperature required, no rare metals being used. The couples can hence be of large cross-section, rendering practically negligible any variation in their resistance by the variation of temperature along the length of the elements. The indicator is a low-resistance Weston millivoltmeter. The compensating device, for correcting for change of temperature at the cold ends, consists of a bulb containing mercury, into which dips a platinum wire loop. The mercury rising in the stem short-circuits more and more of the loop, thus reducing the resistance of the circuit by the necessary amount. For temperatures above 2,000° F. a compound couple is used, consisting of an ordinary platinum-rhodium couple placed where it is exposed to the full heat, and extending to where the temperature is not over 1,200° F., from which latter point to the cold ends the inexpensive alloy couple is used. Various applications are discussed.

L. H. W.

1594. *Conduction of Heat in Non-homogeneous Bodies.* **L. Meitner.** (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 125–137, Feb., 1906. From the II. phys. Inst. der k.k. Univ., Wien.)—Maxwell has given a formula for the specific electrical resistance K of a non-homogeneous medium, consisting of a substance of specific resistance k_2 in which are distributed a number of little balls, whose total volume is to that of the medium as $p : 1$, and whose specific conductivity is k_1, p being a small quantity—

$$K = \frac{2k_1 + k_2 + p(k_1 - k_2)}{2k_1 + k_2 - 2p(k_1 - k_2)} \cdot k_2.$$

Experiments were made with a mercury paste, the mercury globules in which had a mean diam. of 0·00178 mm., and p had the value 0·02693. The paste was put between two parallel discs of copper, the upper of which was separated from a third similar disc by small bits of glass, giving a layer of air of known thickness. The upper plate was heated by steam and the temperatures of the three plates were measured by thermometers, the temperature of the room being taken with a fourth, and all four calibrated against a standard. k_1 is then calculated, using formulæ given by Christiansen and Winkelmann. From Maxwell's formula K should have, for the mixture taken, the value 3803×10^{-8}; the value obtained by the author was 3875×10^{-8}, which shows an error of 1·9 per cent.

A. W.

1595. *Volume and Temperature Changes during cooling of Cast Iron.* **T. Turner.** (Iron and Steel Inst., Journ. 69. pp. 48–67; Discussion, pp. 68–74, 1906. Engineering, 81. pp. 705–707, May 25; Discussion, p. 642, May 18, 1906. Metallurgie, 3. pp. 317–328, May 22, 1906.)—Metals may exhibit no halt in their contraction during cooling, or there may be one, two, or three marked retardations. To the former class belong many pure metals, and certain alloys (*e.g.*, Al-Zn); to the second, high carbon steels and white cast-iron, an example of this sort, a pure white iron containing 2·73 per cent·

combined carbon, showing a retardation of contraction at 665° C.; Cu-Zn alloys also behave in a somewhat analogous way. Non-phosphoric grey cast-iron is an example of the third type, showing actual expansions shortly after solidification (about 1,185° C.) and at 695° C. A grey pig-iron, with 1·25 per cent. phosphorus exemplifies the fourth class; the three expansions occur at 1,060°, 900°, and 730° C. respectively. All of these points in the case of the cast irons correspond to the thermal critical points. The author's view is that the retardation at about 700° C. corresponds to the separation of temper-carbon. An increase of Si raises the temperature at which the retardation (of shrinkage) is observed, and increases the amount of retardation. F. R.

1596. *Emission Power and Temperature of Welsbach Mantles with Various Percentages of Cerium.* **H. Rubens.** (Ann. d. Physik, 20. 3. pp. 593–600, June 26, 1906.)—The author has experimented with mantles consisting of pure ThO_2 and also containing from 1 to 5 per cent. of Ce_2O_3; he has determined the reflecting power of the mantle when cold and when heated in a Bunsen flame. The results show that the reflecting power of the heated mantle divided by that of the cold decreases with increase of the percentage of Ce_2O_3. The emission power, therefore, increases in the red with increase of Ce_2O_3, but decreases in the blue. E. C. C. B.

1597. *Freezing-point of Copper.* **P. Dejean.** (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 3. pp. 149–158, July 1, 1906.)—The freezing-point of copper, lying near that of silver and gold, would form a convenient fixed point for pyrometric purposes if it were known with sufficient accuracy; the authors give a table of the freezing-points as determined by previous workers, which vary from 1,035° C. (L. Guillet) to 1,102° (E. Heyn). The authors use a Pt-Ir thermo-couple, which they standardise daily by the fusion of a small quantity of pure gold wire and occasionally by the fusion of small ingot of pure gold; as further fixed points they have taken the freezing-point of Al (655° C.) and the boiling-point of sulphur (445° C.). The cooling curves have been photographically recorded by the aid of a Schneider-Carpentier induction relay, giving a curve having temperatures as abscissæ and rate of cooling as ordinate, thus giving a minimum at the freezing-point. The couples were protected by a coating of pipe-clay, the end of the junction itself being, however, left uncovered. The actual cooling-curves are reproduced in the paper, the freezing-point of gold being registered on each sheet for direct comparison. The freezing-points of pure Cu and of Cu containing various proportions of oxide were observed, and also, as a further check, the freezing-points of a series of Cu-Al alloys. The authors conclude that, if it be admitted that the freezing-point of pure gold is 1,065° C., then pure Cu freezes at 1,085° C.; it forms with its sub-oxide a eutectic containing between 4·5 and 5 per cent. of oxide; the freezing temperature of this eutectic is near 1,065° C. It falls from this value in proportion as the percentage of oxide present decreases, and this inclination of the eutectic line appears to be due to certain impurities in the Cu, which are almost entirely dissolved in the oxide. (These conclusions differing considerably from the results of Heyn, have been verified with special care by the present authors.) If the freezing of ordinary Cu is to be utilised as a fixed point in the calibration of thermo-couples, the Cu should be melted in an open crucible so as to oxidise freely. If the fusion has not taken too long, the resulting Cu will contain 2 to 3 per cent. of cuprous oxide, and the solidification of such a mixture takes place in two stages, the second arrest taking place at a temperature which lies very near 1,062° C. W. Ros.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1598. *Ratio of the Electrical Units.* **Rayleigh.** (Phil. Mag. 12. pp. 97–108, Aug., 1906. Electrician, 57. pp. 827–828, Sept. 7, and pp. 859–860, Sept. 14, 1906.) —The most approved methods involve the construction either of a condenser or of an electrometer; in the present paper these methods are compared and some suggestions made for future experiments. The first method offers the greatest advantages; there are, however, one or two matters as to which doubts may arise. Thus it is essential that the commutator which charges and discharges the condenser should introduce no e.m.f. of its own. Again, the galvanometer should indicate exactly the *mean* current whether the current be steady or intermittent, and there is some doubt about the possibility of this when steel magnets are employed in the suspended system of the galvanometer. The use of a galvanometer of the d'Arsonval type or that of Einthoven would appear to be preferable. Another question relates to the capacity of the leads; the author suggests a form of condenser which eliminates this question and also dispenses with the usual guard-ring. The principle is that of the variable condenser described in Maxwell's "Electricity," § 127. The condenser is built up of 3 outer and 2 inner cylinders; by the removal of 2 of these a second condenser is obtained and the diminution of capacity is accurately that of these intermediate cylinders. Particulars of the calculation are given. The best form of absolute electrometer is that in which an inner cylinder moves coaxially in the interior of 2 fixed coaxial cylinders; the author believes that the best means of measuring the force between these is by means of an ordinary balance. The weakest point in such an arrangement is the high potential required to attain the necessary sensitiveness; the objection is not so much the difficulty of obtaining the potential with steadiness as the risk of a brush-like discharge through the air. The author, while disposed to give the preference to the condenser, is of opinion that the electrometer method is worthy of further trial. F. E. S.

1599. *Exhibition of Electrical Lines of Force.* **W. Holtz.** (Ann. d. Physik, 20. 3. pp. 591–592, June 26, 1906.)—A piece of silver-paper (zinc) is laid on the table and the ends of two wires in connection with the electrical machine are brought in contact with it. In a dark-room the direction of the lines of force between the points may be seen by means of small reddish-coloured sparks. If imitation gold-leaf (copper) be used, the lines are seen in a green colour. By shaking up pieces of gold-leaf in alcohol until the leaf is finely broken up and applying a p.d. of 70 volts between two Pt wires dipping into the liquid, the lines of force are again evident. Finely divided silver- and aluminium-leaf in water, alcohol, and petroleum give similar results. S. G. S.

1600. *Determination of Atmospheric Electrification.* **W. Holtz.** (Ann. d. Physik, 20. 3. pp. 587–590, June 26, 1906.)—To avoid the methods of the insulated flame and the water-dropper, which are defective owing to the electrification produced in the method itself, the author has devised three methods in which metallic conductors only are used. In the first an insulated swinging conductor makes contact with the insulated plate of a condenser;

after a time the earthed plate is removed and the deflection of the electroscope is then a measure of the atmospheric electrification. The second and third methods are modifications of the first; in the third, the moving conductor consists of two insulated rotating zinc vanes driven by a motor. The results of some of the experiments are given. S. G. S.

1601. *Ionisation in the Atmosphere.* **H. Knoll.** (Akad. Wiss. Wien, Sitz. Ber. 115, 2a. pp. 161–172, Feb., 1906. From the Inst. f. theoret. Physik an der k.k. Univ., Wien.)—The potential-fall between two concentric spheres was observed by means of an Elster and Geitel electroscope. Experiments were carried out in a room whose volume was 6 × 5½ × 4 m.³, and also in a cellar of almost the same size. The radii of the inner and outer spheres were respectively $r_i = 2{\cdot}5$, 5, 7·5, or 10 cm., $r_0 = 3{\cdot}75$, 5, 7·5, 10, or 15 cm., but most of the results given are for the combination where $r_i = 2{\cdot}5$ cm. and $r_0 = 15$ cm. The inner sphere was sometimes charged positively and sometimes negatively, and tables and curves are given showing how the rate of fall of potential dV/dT varies with the potential. From these, using Riecke's formula for the saturation current, this latter is calculated for different voltages. The following results were obtained; F is the field between the two spheres, q the number of ions which are generated in 1 c.cm. per sec., C_0 the saturation current, and S is given by the equation $C = C_0 - S$:—

$F = \frac{1}{15}$ volt per cm.			$F = \frac{1}{30}$			$F = \frac{1}{300}$		
q	C_0	S	q	C_0	S	q	C_0	S
10	5×10^{-5}	$\frac{3}{2} \times 10^{-11}$	10	5×10^{-5}	6×10^{-11}	10	5×10^{-5}	6×10^{-9}
100	5×10^{-4}	$\frac{3}{2} \times 10^{-9}$	100	5×10^{-4}	6×10^{-9}	100	5×10^{-4}	6×10^{-7}
1,000	5×10^{-3}	$\frac{3}{2} \times 10^{-7}$	1,000	5×10^{-3}	6×10^{-7}	1,000	5×10^{-3}	6×10^{-5}

From these results the mobility of the ions is calculated, and the value obtained for the product UV, where U is the mobility of the positive and V that of the negative ion, is of the order 10^{-19}, which seems to show the presence in the air of ions moving more slowly than those observed by Langevin, for which latter $U = 1{\cdot}74 \times 10^{-8}$ and $V = 1{\cdot}26 \times 10^{-8}$ A. W.

1602. *Atmospheric Electric Potential Results at Kew,* 1898–1904. **C. Chree.** (Roy. Soc., Phil. Trans. 206. pp. 299–334, June 30, 1906. Roy. Soc., Proc. Ser. A. 77. pp. 385–387, April 30, 1906. Abstract.)—Based on observations started in 1894, the old apparatus was remodelled, important alterations being made in the size of the tank, the length of connecting pipe, and in the direction of emission of the jet, which is now parallel to the wall of the building, as it was found that the change of potential was least in this direction. For control, a system of absolute eye observations were made regularly in the open. In order to avoid the uncertain action of rain, it was decided to confine the discussion to 10 days a month having no rainfall. Tables are given showing the mean monthly and annual values of the potential gradient, from which it is shown that although the element is very variable, for which 7 years are scarcely long enough to bring out all the details, there is unquestionably a well-marked minimum near midsummer. A second minimum appears to exist in Jan., but the observations at this time of the year are much interfered with by atmospheric fog, &c. Several features seem to indicate that the potential gradient tends to be *lower* than usual during times of sun-spot minimum. Other tables are given showing the non-cyclic elements, diurnal inequalities. The daily range, when considered absolutely, is greater in winter than in summer; but relative to the mean value of P for the day, the day and night falls and the range all show a decided minimum in Nov., Dec., and Jan. If the potential gradient is due to a negative charge on the earth, the density of that charge is on the average greater in winter than in summer, but the diminished charge of summer is, relatively considered, more influenced by the causes to which the regular diurnal inequality is due. A detailed discussion of similar investigations by Everett and Chaveau is included, showing the variations found at scattered stations. Analyses by Fourier series appear to indicate that the 8- and 6-hour terms represent a true atmospheric electricity effect. These waves are decidedly smaller at Kew than at the Bureau Central, and the fact that these terms are also smaller at the Eiffel Tower suggest that the reason of the variation may be the effect of the height of the station. In discussing the connection of atmospheric potential with the variations of the meteorological elements, the chief feature showing a good comparison is the barometric pressure. While the general form of the two curves is very similar, there are fundamental differences in detail. They are nearly in the same phase during the forenoon, but in the afternoon the lag in the barometer curve becomes conspicuous, amounting to about 2 hours at the times of the afternoon maximum and minimum. Moreover, this change in apparent lag persists throughout the year. C. P. B.

1603. *Aurora Borealis.* **P. Villard.** (Comptes Rendus, 143. pp. 143–145, July 9, 1906.)—In continuation of a former note [see Abstract No. 1429 (1906)] the fundamental characters of the trajectory of a kathode ray in the equatorial plane of the earth's field are deduced from simple geometrical considerations, and two illustrative photographs of kathode rays are given. The conclusions are drawn that if the sun has a sensible magnetic field kathode rays cannot leave it, but will simply move in a zigzag sheet about the axis of the field; that, the sun's rotation being but slow and the earth's magnetic field near the sun being but weak, a kathode beam turning with the sun would produce an aurora of but very short duration; that the zigzag sheet constituting the aurora ought to contain the source of emission so that, if this were the sun, the sheet would be of enormously larger dimensions than is actually the case; that consequently the source of emission is necessarily terrestrial. [See also next Abstract.] R. E. B.

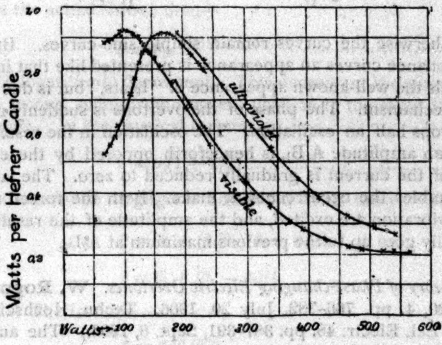
1604. *Trajectories of Electric Corpuscles in the Earth's Magnetic Field and the Aurora Borealis.* **C. Störmer.** (Comptes Rendus, 142. pp. 1580–1583, June 25; 143. pp. 140–142, July 9, 1906.)—The differential equations of the trajectories of kathode rays in the magnetic field due to an elementary magnet are given; they are not integrable, but the trajectories can be numerically deduced from them with sufficient approximation. The results of such calculation would, on Birkeland's theory, be applicable to auroræ and magnetic perturbations. In the second note an account is given of a calculation of twelve different trajectories for corpuscles that approach the origin, with an indication of others, some of which are of extremely complex spiral form. It appears that if auroræ are due to corpuscles emanating from the sun, the trajectories which reach the earth are confined within a narrow limit, but that their directions, as also the number of corpuscles, vary very greatly with an angular magnitude which depends on the time, so that the very varied aspect and brusque changes of the auroral phenomena, as also the magnetic perturbations, can be fully accounted for. R. E. B.

DISCHARGE AND OSCILLATIONS.

1605. *Electron Theory of Gas Discharges.* **A. Righi.** (Écl. Électr. 48. pp. 5–18, July 7, 1906. From the Italian.)—The author's researches on electric discharges through gases were, since 1872, led by the idea of charged molecules. He now revises some of these in the light of the electron theory, which furnishes a rational basis for the hypothesis of discrete charges. He points out that his own theory differed less from the modern theory than appears at first sight, but that the electron theory throws a new light on the origin of the ions. Ionisation by ionic shock is fully confirmed, but the author would not restrict it to gases. It is also found in liquids. The phenomena presented by the discharge through water and other liquids between small electrodes, as in the Wehnelt interrupter, or through constrictions, resemble the corresponding gas discharges in many particulars. Ionic shock in liquids produces a discharge resembling a gas discharge, but essentially different from electrolysis. In the latter, the signs of the ions produced depends upon their chemical nature. Ionisation by shock is mechanical, and affects all atoms and molecules in the same general manner. Thus it comes about that a mixture of hydrogen and oxygen is formed at both electrodes. The author gives an explanation of globular discharges based on ionic shock. The potential goes on increasing for some time after the discharge has commenced, on account of the high resistance in the circuit, especially in nitrogen. Now, the path necessary for ionisation by ionic shock depends upon the potential gradient. This gets steeper as the p.d. increases. Hence the electrons from the kathode have a smaller distance to traverse than at the beginning of the discharge, and the luminosity shifts slowly towards the kathode. The phenomenon is best seen in nitrogen. If there is sufficient room between the electrodes, there may be several successive shock paths, and several globular discharges at the same time. E. E. F.

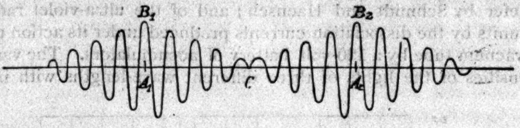
1606. *Radium and the Visible Electric Discharge* in Vacuo. **A. A. Campbell Swinton.** (Phil. Mag. 12. pp. 70–73, July, 1906. Communicated by the Physical Soc.)—It is found that the presence of radium on the kathode materially increases the amount of current that passes through a vacuum tube with any given voltage. When the radium is not heated the effect is not noticed, but when the radium-coated kathode was heated to redness there was a very marked effect in facilitating the production of a luminous discharge. A strip of Pt-foil was used in some experiments; this before mounting in the tube was dipped into a solution of radium bromide and dried. The amount of radium on the foil must have been extremely small, but with a suitable vacuum, and with the kathode heated to a bright red colour, the discharge passed and the gas in the tube lighted up brightly with electrical pressures as low as about 80 volts. In various other cases it was always found that a visible discharge could be made to pass, using the radium-treated electrode, with about 100 volts less than when the untreated electrode was employed. J. J. S.

1607. *Photometry of Mercury Arc with High Vapour Pressure.* **R. Küch** and **T. Retschinsky.** (Ann. d. Physik, 20. 3. pp. 563–583, June 26, 1906. Communication from the Laborat. der Firma W. C. Heraeus. Écl. Électr. 48. pp. 211–219, Aug. 11, 1906.)—The arc was produced in a quartz lamp of suitable form, which was able to withstand pressures ranging between 0·2 and 150 cm. of mercury, the corresponding ranges, in volts, being from 36 to 249 volts, and in current from 2·78 to about 4·5 amps. The bulbs containing the mercury electrodes were proportional in size to the quantities of heat produced at the electrodes, and the kathode end was so constructed as to automatically adjust the discharge so as to keep the heat produced roughly constant for any particular voltage used. With a load of about 650 watts and vapour pressure of 80 cm. the walls of the tube rose to a dull red heat, indicating that the mercury vapour was unsaturated. Photometric measurements were made of the visible radiation as a whole by means of a flicker photometer by Schmidt and Haensch; and of the ultra-violet radiation in special units by the dissociation currents produced under its action through a quartz vacuum tube by a 120-volt battery of accumulators. The variation of the intensities of the lights of three different wave-lengths with increasing loads was studied by means of a spectrometer provided with polarising prisms for equalising the intensities with those of similar rays from a Nernst lamp. The Fig. is typical of the results obtained for the visible and ultra-violet radiations. The vertical scale in watts per Hefner candle refers to the visible radiation; the curve for the ultra-violet radiation being merely reduced to the same maximum ordinate. With a load of between 1,100 and 1,200 watts, the watts per mean spherical Hefner candle reached the very low figure of 0·185. In the continuous spectrum it was found that the intensity of light of small wave-lengths increased with load more rapidly than that of greater wave-lengths, and the various groups of lines exhibited different rates of increase of intensity. Curves illustrating this point are given. [See also Abstracts Nos. 76 (1904), 1210 (1905), and 520, 1055 (1906).] J. D. C.



1608. *Resistance of Electrolytes for Currents of High Frequency.* **A. Broca** and **S. Turchini.** (Comptes Rendus, 142. pp. 1187–1189, May 28, 1906. Ind. Élect. 15. pp. 289–290, June 25, 1906.)—Measurements were made of the heating effect of an alternating current of frequency 190,000 to 3,000,000 when passed through acidulated water containing (1) 1/10 acid and (2) sulphuric acid of maximum conductivity. The heating effect was compared with that of an alternating current of equal intensity but lower frequency. From these observations the relative resistance of the electrolyte at different frequencies was deduced, and, contrary to theoretical expectations, the resistance was found to decrease as the frequency increased. T. M. L.

1609. *Phase-changing Electric Overtones.* **B. Strasser** and **J. Zenneck.** (Ann. d. Physik, 20. 4. pp. 759–765, July 20, 1906. Phys. Inst. d. techn. Hochschule, Danzig-Langfuhr. Écl. Électr. 48. pp. 385–386, Sept. 8, 1906.)—Two classes of harmonics may be distinguished by ocular observation with the aid of a Braun tube. As the frequency of the oscillation impressed upon a condenser circuit is increased, increased amplitudes are obtained near the points of resonance with the fundamental or higher harmonic period of the circuit. Otherwise the curves remain simple sine-curves. But in another class of resonance curves an appearance is presented like that in the diagram, which recalls the well-known appearance of "beats," but is due to an entirely different mechanism. The phase of the overtone is suddenly reversed at A_1, so that it drops half an oscillation. The oscillation in the resonating circuit, which has an amplitude A_1B_1, is henceforth opposed by the e.m.f., and the amplitude of the current is gradually reduced to zero. The last half of the period resembles the occurrences at make. Both the forced vibration and the proper vibration are excited, and the amplitude of the resultant vibration only gradually goes up to the previous maximum at A_2B_2. E. E. F.



1610. *Theory of Phase-changing Electric Overtones.* **W. Rogowski.** (Ann. d. Physik, 20. 4. pp. 766–782, July 20, 1906. Techn. Hochschule, Danzig-Langfuhr. Écl. Electr. 48. pp. 387–391, Sept. 8, 1906.)—The author deduces the production of phase-changing overtones described by Strasser and Zenneck [see preceding Abstract] from the relation between the forced oscillation and the proper oscillation of the system. He shows that the resonance curve, *i.e.*, the curve whose abscissæ are frequencies and whose ordinates are effective currents in the measuring instrument, differs accordingly as the overtones do, or do not, change their phase. If they do, there are several maxima in the neighbourhood of the usual maximum of

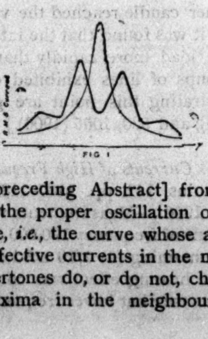


FIG 1

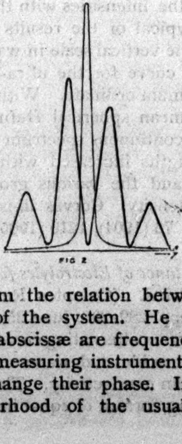


FIG 2

resonance. These maxima are shown by the thick curves in the diagrams. The inductance in the circuit was 0·80 henry. The proper frequency was 5,660, and the resistance was 160 ohms in the first case and 16 ohms in the second case. The scale of ordinates is reduced 5 times for the second diagram. E. E. F.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1611. *The Formula for the Damping Factor of a Ballistic Galvanometer.* **R. Swyngedauw, E. Brylinski, Chaumat.** (Ind. Élect. 15. pp. 373–377, Aug. 25, 1906.)—*L'Industrie Électrique* appealed to its readers for help in explaining the divergencies existing in the received formulæ for the damping factor of a ballistic galvanometer. Three of them replied. They all start with the assumption that the differential equation expressing the motion of the moving part is linear and of the second degree. It easily follows that if θ be the theoretical throw calculated on the assumption that the damping is zero and θ_1 is the actual throw, then—

$$\theta = \theta_1 \epsilon^{(\lambda/\pi)\tan^{-1}(\pi/\lambda)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\text{i.})$$

where λ is the logarithmic decrement. This decrement is defined as follows: If θ_3 be the second swing from the zero position in the same direction as θ_1, then $(\theta_1/\theta_3) = \epsilon^{2\lambda}$ In the classical formula—

$$\theta = \theta_1(1 + \lambda/2) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\text{ii.})$$

$\lambda^2/8$ is supposed to be negligible compared with unity. The empirical formulæ—

$$\theta = \theta_1 + (\theta_1/\theta_3)(\theta_1 - \theta_3)/4$$

or approx.—

$$\theta = \theta_1 + (\theta_1 - \theta_3)/4, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\text{iii.})$$

are also used. The formula—

$$\theta = \theta_1(\theta_1/\theta_3)^{\frac{1}{4}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\text{iv.})$$

is attributed to A. W. Smith. Swyngedauw states that if θ_3/θ_1 is not less than 0·8 the max. inaccuracy of any of these formulæ is less than 1 per cent. To this accuracy Smith's formula is correct when θ_3/θ_1 is not less than 0·55 and the classical formula when θ_3/θ_1 is not less than 0·35. Brylinski gives a table showing how the approximate formulæ (ii.), (iii.), and (iv.) compare with the correct formula (i.). He points out that the cases in which (ii.) should not be used in practice are rare. Chaumat gives the correct formula in the form—

$$\theta = \theta_1(1 + \lambda/2 + \lambda^2/8 + \ldots - \lambda^2/\pi^2 - \lambda^3/2\pi^2 - \lambda^4/8\pi^2 - \ldots),$$

when λ is less than π. He shows that formula (iv.) cannot possibly be an exact formula. In his opinion, however, the calculation of the throw of a galvanometer on the supposition that there is no damping is absolutely puerile. It is much simpler and more correct to standardise the ballistic galvanometer in each case in the actual conditions of working. This is the method he has adopted for the last ten years at *l'École supérieure d'électricité*.

A. R.

1612. *Behaviour of Selenium towards Alternating Currents.* **A. Pochettino** and **G. C. Trabbachi.** (Accad. Lincei, Atti, 15. pp. 27–35, July 1, 1906.)—By a Wheatstone bridge method the authors have studied the influence of alternating currents on the resistance of selenium cells in the light and in the dark. For the purpose of the inquiry two methods of preparing the cells are distinguished, according to whether the selenium is kept at a temperature of 190° for some time until the transformation of the selenium is complete (cells of the first kind) or surrounded by a bath of molten lead and then allowed to cool slowly (cells of the second kind). All selenium cells, whether of the first or second kind, after exposure to an alternating current show an increased resistance; the increase is temporary and the cell returns to its original condition in a week if of the first kind, and in a day, or day and a half, if of the second kind. Cells of the second kind show a high resistance at first, but this changes spontaneously in about a month to a low and approximately constant value; corresponding with this diminution of resistance there is a gradual diminution of the photo-electrical effect to zero and then to a negative value. Gradually, as the resistance of the selenium cell under the action of the alternating current increases with increasing voltage, the photo-electrical effect changes; in the cells of the first kind there is an increase extending to an asymptotic value varying from cell to cell; for cells of the second kind, in which the photo-electrical effect is initially negative, there is a tendency for the effect to rise to zero and then become positive; the increase is continuous in both cases, but extremely variable from cell to cell. When the resistance returns to the primitive value the photo-electrical effect also changes with equal step to the original figure.

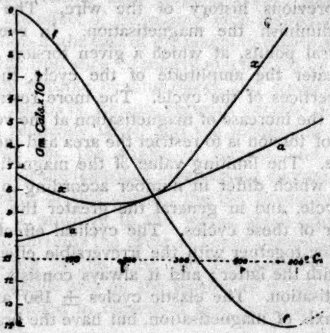
D. H. J.

1613. *Adjustable Choking Coil. Magnetic Engaging Apparatus for Revolution-counters.* **E. Gumlich.** (Electrotechn. Zeitschr. 27. pp. 719–721, Aug. 2, 1906.)—The author describes the construction of a choking coil which can suitably replace an ordinary resistance for alternating-current work. It consists essentially of a coil, in the interior of which is arranged a vertically-movable iron core; this core may be fixed in any position. The central core and the coil are surrounded by several smaller vertical iron cores which are so arranged that, together with two horizontal iron cores a nearly closed magnetic circuit is formed. By moving the central core upwards fewer turns are active in producing an e.m.f. of self-induction, and besides the air-path of the magnetic lines of force is lengthened, so that the current flowing through the circuit will grow. The advantages of such a choking coil over a regulating resistance are: Easy adjustment of current, small consumption of energy (about $\frac{1}{8}$ of that of a corresponding resistance), and partial compensation of the current-variation due to variations of temperature of the windings. The magnetic engaging apparatus for revolution-counters, as used in the Physikalisch-Technische Reichsanstalt in Berlin, enables one to dispense with the services of one operator, for measuring speeds of dynamos, &c. It consists essentially of a shaft which is coupled on one side to a revolution-counter and has on the other side a small, four-armed cross which is driven by an engaging pin on the main shaft (dynamo) if moved towards it. This movement can be effected by an electromagnet and a disc armature, connected to the little shaft by means of a ball bearing. The electromagnet is fed by 4 accumulator cells and consumes 1 amp.

C. K.

1614. *Theory of Thermo-Electricity.* **E. Lecher.** (Ann. d. Physik, 20. 3. pp. 480–502, June 26, 1906. Revised from Akad. Wiss. Wien, Sitz. Ber. 115.

2a. pp. 178–196, Feb., 1906.)—The Thomson-, Peltier-, and Seebeck-effects may be combined in one diagram, and the author does this for the case of iron and silver. The curve *f* represents the Thomson-effect in iron, and shows that heat is absorbed in an iron wire conveying a heat current and an electric current in the same direction. The corresponding curve for silver, marked *a*, shows the reverse effect. The curve *x* indicates the thermoelectric force between iron and silver, which is proportional to the difference between its ordinates and those of the curve *a*. Then the Peltier-effect is the difference between the ordinates of *f* and *x*. The axis of abscissæ can be chosen at random for *f* and *a*, but it is so chosen that *f* cuts *a* at its junction with *x*. If constantan is coupled with iron in the same manner, the diagram must be drawn on a much larger scale, since the Peltier-effect is enormous in comparison. This means that the thermal conductivity of the metals has a decisive effect on their thermoelectric behaviour. E. E. F.



1615. *Electrical Resistance of Palladium.* **F. Fischer.** (Ann. d. Physik, 20. 3. pp. 503–526, June 26, 1906. Extract from Dissertation, Giessen.)—This is a redetermination, within wide limits, of the manner in which the resistance of palladium varies with the amount of hydrogen occluded in it. The first dose of hydrogen immediately and abruptly increases the resistance, but when as much hydrogen has been absorbed as would fill 30 times the volume of the palladium wire at atmospheric pressure, the increase of resistance is proportional to the amount of hydrogen occluded. When the wire has absorbed 950 volumes of hydrogen, the increase of resistance is slackened. In a state of saturation the palladium holds about 1,000 times its volume of hydrogen. Supersaturation with hydrogen produces no further increase of resistance. The hydrogen thus absorbed is given up again spontaneously, without influencing the resistance. The maximum increase of resistance is 69 per cent. The resistance is proportional to $a + b\text{H}$, where H is the number of volumes of hydrogen absorbed, a is 1·0292, and b is 668×10^{-6}. A palladium wire expands, in occluding hydrogen, to the extent of 2539×10^{-8} cm. per cm. and per volume absorbed. Supersaturation produces a comparatively greater expansion; withdrawal of the hydrogen makes the wire shorter than it was originally, but the original resistance is recovered exactly. E. E. F.

ALTERNATING CURRENTS AND MAGNETISM.

1616. *Magnetic Variations in Iron under Torsion.* **F. Piola and L. Tieri.** (Accad. Lincei, Atti, 15. pp. 566–574, May 20, 1906.)—Taking Ewing's distinction (" Magnetic Induction in Iron," p. 231, 1900) between the irreversible diminution in the magnetisation of an iron wire, twisted or untwisted, while in a longitudinal magnetic field, which diminution depends on the previous history of the wire, and the cyclical effect under the same conditions, which Ewing treated as being independent of the previous history of the wire, the author has studied the relations between the variations produced by torsion and the previous history of the wire. The irreversible effect is not always to diminish the magnetisation. In every magnetic cycle there are two neutral points, at which a given torsion produces no variation; and the greater the amplitude of the cycle, the nearer are these two points to the vertices of the cycle. The more restricted the magnetic cycle, the greater is the increase of magnetisation at the vertices of the cycle. The limiting effect of torsion is to restrict the area and increase the height of the hysteresis cycle. The limiting value of the magnetic moment depends upon elastic cycles which differ in number according to the different points of the magnetic cycle, and in general the greater the total variation the greater the number of these cycles. The cyclical effect depends upon the limiting magnetisation together with the irreversible effect, and increases or vanishes together with the latter; and it always consists in a diminution of the limiting magnetisation. The elastic cycles ± 180° are not symmetrical with regard to the axis of magnetisation, but have the branch corresponding to positive torsion shorter than the other. On varying the amplitudes of torsion, starting always from points of the magnetic cycle and reaching the limiting point, cyclical effects are observed which differ according to the different cases; with torsions of sufficient amplitude the elastic cycle is traversed in an opposed direction, presenting negative hysteresis; and for one particular degree of torsion the area of the elastic cycle sensibly disappears. The cause of the asymmetry of the elastic cycle curves lies in this—that the magnetic effect depends, not upon the deformations, but upon the forces which produce them. A. D.

1617. *Hysteresis in a Rotating Field.* **R. Arnò.** (Accad. Lincei, Atti, 15. pp. 691–692, June 17, 1906.)—The author has continued his experiments [see Abstracts Nos. 1048, 1289, and 2289 (1905)], this time with a view to determining the effect of an alternating current of given intensity and frequency upon the hysteresis cycle of the steel cylinder in a rotating field the strength of which is constant, but whose frequency can be varied. The impedance of the winding through which the current was passed was maintained constant by varying the amount of additional ohmic resistance in series with such winding. As a result, the following three paragraphs can be added to the eleven conclusions previously set forth: (12) The effects of a given alternating current on the hysteresis cycle of the steel are different according to the frequency of the Ferraris field in which the steel is suspended. (13) By varying the frequency of the rotating field, all other experimental conditions being kept unaltered, either a diminution or an increase of hysteresis [loss] can be obtained. (14) For an alternating current of given intensity and frequency, and for a given strength of the rotating field, there is a certain frequency of field at which neither increase nor decrease of hysteresis [loss] takes place as a result of the action of such current. L. H. W.

1618. *Sensibility of the Magneto-elastic Detector.* **L. Tieri.** (Accad. Lincei, Atti, 15. pp. 94–95, July 15, 1906.)—The author here investigates the relation between the sensibility and the torsion [see Abstract No. 767 (1906)], the angular values of the torsion being plotted as abscissæ, and as ordinates the magnetic moments obtained from magnetometer observations. The following results are obtained: (1) The sensitiveness of an iron wire to electric waves when the wire is taken through a definite cycle of torsion, depends upon the inclination to the axis of abscissæ, of the curve enclosing the hysteresis cycle, increasing with such inclination as in the case of the magnetic cycle [E. Wilson, B.A. Report, 1902]; and since a circular magnetisation has the effect of increasing such inclination, the effect of the circular magnetisation in the case of the magneto-elastic detector is accounted for. (2) Keeping the iron wire circularly magnetised by a current not large enough to have any sensible heating effect, and constructing the magnetic hysteresis cycle by means of torsion, between definite limits, the area of the hysteresis cycle is relatively large, and the inclination of the curve which encloses it, is large for the angles of torsion, and small for those of detorsion. Increasing the (circular) magnetising current, the area decreases, and at a certain value of this current the two branches coalesce. Even in this case the wire is sensitive to the waves, about equally all through the cycle; with intense currents the cycle is hence complicated by other effects, including the heating of the wire. (3) The sensitiveness of a circularly magnetised wire depends also on the tension to which it is subjected; with increasing weight applied in tension, it first increases, reaches a maximum, and then diminishes. L. H. W.

1619. *Effect of Electrical Oscillations on Magnetised Iron.* **W. H. Eccles.** (Phil. Mag. 12. pp. 109–119, Aug., 1906. Communicated by the Physical Soc. Electrician, 57. pp. 742–744, Aug. 24, 1906. Abridged.)—Employing, contrary to Maurain, oscillations so feeble that only the outermost layers of the iron wires used should have been affected, and further, using only a single train of waves (single ½-mm. spark from an influence machine), the author has obtained quantitative results for hysteresis cycles with co-directional oscillations, for the case in which oscillations are superposed after a change of field ["A-Conditions" of Russell, see Abstract No. 1119 (1906)]. The unannealed charcoal iron wire employed was made up into twin solenoids, as in Tissot's differential detector, but the change of flux was in this case examined by a magnetometer. One wire of the oscillation winding was connected direct to the spark-gap and the other left insulated. Whilst no new results are obtained, the quantitative results are fully given, and the method of presenting these data brings out several interesting points. Thus, with increasing cyclic amplitudes the effect of the same spark is increased; the effect of oscillations in small cycles is for some reason smaller than the diminished gradient would lead one to expect. Further, the magnitude of the effect at any point is closely connected with the slope of the hysteresis curve, thus confirming E. Wilson's view [B.A. Report, 1902]; the curves representing the effect of the spark are given in the original alongside the gradient curve (first derived curve) of the particular cyclic curve. Speculations follow as to the actual forces at work, and the possibility of the alteration in stored energy produced being greater than the initial energy of the oscillations producing such alteration. L. H. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1620. *Physical Constants of Ammonia.* **E. P. Perman** and **J. H. Davies.** (Roy. Soc., Proc. Ser. A. 78. pp. 28–42, July 21, 1906.)—The following results have been obtained by the authors: The vapour density of ammonia (mass of 1 litre in gm. at latitude 45°) at 0° is 0·77085. When the ammonia and the glass vessel are thoroughly dried, no appreciable absorption of ammonia by glass or condensation of ammonia on the surface of the glass, takes place. The coefficient of expansion of ammonia is 0·003914 between 0° and —20°, and 0·003847 between 0° and 100°. The above numbers, together with Rayleigh's value for the compressibility of ammonia, give the molecular weight 17·030 for ammonia, and the atomic weight 14·007 for nitrogen. The density of air free from water vapour and CO_2 is 1·2920 (lat. 45°). The deviation from Dalton's law for a mixture of about equal volumes of air and ammonia is about 1 part in 1,000. The pressure being atmospheric at 15°, the pressure-coefficient of ammonia is 0·004003 between 0° and —20°, and 0·003802 between 0° and 98°. T. H. P.

1621. *Absorption of Nitrogen by Organic Substances under Influence of Radio-active Bodies.* **Berthelot.** (Comptes Rendus, 143. pp. 149–152, July 16, 1906.)—The author placed 1·424 gm. of white blotting-paper in a tube containing 29·1 c.cm. of air together with 0·02 gm. of radium chloride, sealed off the tube, surrounded it on the outside with a double layer of grey paper, and left it for 11 months in a cupboard; at the end of the time the tube contained 17 c.cm. of gas only, viz., 15·5 c.cm of N, and 1·5 c.cm. of CO_2. 7·6 c.cm. of N and 6 c.cm. of O had thus disappeared, and it was found that both these gases had been fixed by the paper, which had become slightly yellow, especially at the part nearest to the radium salt. The paper on the *outside* of the tube was unaltered, so that the effect on the blotting-paper was due to rays which do not penetrate glass. D. H. J.

1622. *Absorption-coefficient of Gases as Dependent upon Surface Tension.* **A. Christoff.** (Zeitschr. Phys. Chem. 55. pp. 622–634, June 8, 1906. Chem. Laborat. d. Univ., Sofia.)—The absorption-coefficient of air in 95·6 per cent. sulphuric acid is identical with that of air in water. The solubilities in the two liquids are also very similar in the case of H, N, O, CO, CO_2, and methane, but alcohol and petroleum dissolve much larger quantities of these gases. In the case of each gas there is a minimum solubility at intermediate concentrations in mixtures of sulphuric acid and water; this minimum corresponds roughly with a maximum surface tension at about 50 per cent. H_2SO_4. The solubility of CO in a series of nine pure solvents appears to be largely determined by surface tension; the smallest solubility is found in liquids of high surface tension and *vice versâ;* the product of surface tension and absorption-coefficient is of the same order of magnitude throughout. T. M. L.

1623. *Combination of Hydrogen and Oxygen in Contact with Hot Surfaces.* **W. A. Bone** and **R. V. Wheeler.** (Roy. Soc., Phil. Trans. 206. pp. 1–67, May 29, 1906. Proc., Ser. A. 77. pp. 146–147, Feb. 8, 1906. Abstract.)—The authors have studied the velocity of combination of hydrogen and oxygen in contact with various substances, metals and oxides, with a view to the elucidation of their catalytic influence on this gas reaction, the gases being caused to circulate over the different substances heated in a combustion furnace, the temperature of which was regulated by means of a Stott's governor. The tubes were all fused together and indiarubber connections avoided. The main results obtained are as follows: Contrary to the view of Bodenstein and of Nernst, the authors' experiments lead to the view that the catalytic action of porcelain is primarily due to the condensation or occlusion of one, and possibly both, of the reacting gases on its surface. Whenever one or other of the gases is in excess, the rate of combination is proportional to the partial pressure of the hydrogen. This, when taken with the fact that the porcelain absorbs H at a red heat, indicates that the occluded H is an all-important factor. The velocity of combination can be increased by previously treating the porcelain either with H or with O; whereas excess of H always produced a *continuous* acceleration throughout a given experiment, any acceleration due to an excess of O was manifested only during the initial stages. The authors therefore suggest the following explanation of the catalytic process: Porous porcelain occludes or condenses both H and O at rates which depend to some extent upon the physical condition and past history of the surface. In the case of calcined magnesite it was found that (1) with normal electrolytic gas the rate of combination is proportional to the pressure of the dry gas, (2) when an excess of either of the reacting gases is present the rate is determined mainly by the partial pressure of the H, and (3) the catalysing power of the material is, on the one hand, greatly stimulated by H, but, on the other hand, diminished by O. These considerations, together with the fact that the material occludes H, but not O, at red heat, show that its catalytic action must be referred to its power of occluding H. In the case of Ag, Au, Pt and Ni there is substantial agreement in respect of four important particulars. (1) The catalytic action is in each case primarily due to an association of the surface with H; in the case of Ag probably to the formation of an unstable silver hydride, in the other three cases to an occlusion of the gas. (2) With normal electrolytic gas the rate of combination is proportional to the pressure of the gas. (3) Whereas the activity of the surface may always be stimulated by previous exposure to H at moderately high temperatures, oxygen, *per se*, has no such accelerating influence, but rather, owing to its "dehydrogenising" action, the reverse. (4) When an excess of either gas is present, the rate of combination is nearly proportional to the partial pressure of the H. The evidence in favour of the "occlusion" theory is particularly strong in the case of Ni, where the "normal" condition of activity can be reduced to almost vanishing-point by prolonged exhaustion at a comparatively low temperature. Moreover, the subsequent recovery of activity can be demonstrated by circulating successive charges of electrolytic gas over the surface under conditions which entirely preclude any chemical action of either of the reacting gases on the metal. In the case of calcined spathic iron ore, copper oxide and nickel oxide, the results seem to be incompatible with any purely chemical explanation of the catalytic process. In the case of copper oxide it would appear to involve the condensation of a film of "active" oxygen on the surface, and that this film actually protects the catalysing oxide from the attacks of the H, which would otherwise energetically reduce it. At low pressures the film becomes too attenuated to ensure complete protection and, in consequence, the formation of steam is accelerated by reason of H penetrating through to the oxide and reducing it; the rate of steam formation when the gases are not present in combining ratios was found to be proportional to the partial pressure of the oxygen. The behaviour of the other reducible oxides examined also does not harmonise with the purely chemical theory. Since in all experiments where the gases were not present in combining ratios the rate of combination was always proportional to the partial pressure of the hydrogen, it would appear to be the hydrogen which is condensed and so rendered active. A. F.

1624. *Solubility of Lead in Tap-water.* **T. Paul, W. Ohlmüller, R. Heise,** and **F. Auerbach.** (Arb. a. d. Kaiserl. Gesundheitsamt, 23. pp. 333–388. Reviewed by F. Auerbach in Zeitschr. Elektrochem. 12. pp. 428–430, June 22, 1906).—The water tested was moorland water containing very little dissolved solid. The solubility of lead in water is largely determined by the presence of oxygen; but this was initially present only in small quantities; thus under specified conditions the water dissolved initially less than 1 mgm. Pb per litre, whilst distilled water saturated with air dissolved 115 mgm. The second important factor was carbonic acid in various forms; free carbonic acid was found to increase the solubility of lead, but bicarbonates decreased the solubility; sulphates, and probably other salts, increase the solubility. T. M. L.

1625. *Reduction of Molybdenum Dioxide by Boron, and Combination of Boron with Molybdenum.* **B. du Jassonneix.** (Comptes Rendus, 143. pp. 169–172, July 16, 1906.)—Pure metallic molybdenum is obtained by heating a mixture of MoO_2 with the theoretical quantity of boron in a boat of magnesia, in the electric furnace, the heating being stopped as soon as fusion commences. Employing boats or crucibles of magnesia, alloys of B and Mo containing from 2 to 45·6 per cent. B have been prepared, entirely free from any crystalline compound, those with up to 20 per cent. B being white and brittle, with densities falling from about 9 to 6 with increase of boron, while those containing over 20 per cent. B gradually lose their metallic appearance, assume a bluish-grey colour, and decrease in density to 3·3.

W. H. Sr.

1626. *Amicroscopic Gold Nuclei.* I. *Colloidal Silver.* II. **R. Zsigmondy.** (Zeitschr. Phys. Chem. 56. pp. 65–76, and pp. 77–82, July 17, 1906.)—I. The reduction of a slightly alkaline solution of gold chloride by means of formaldehyde is affected by the purity of the water used; the purer the water the longer does it take for the liquid to show a red colour (formation of colloidal gold). If to a mixture in which the red colour only slowly appears a small amount of a homogeneous colloidal gold solution is added, the red colouration appears immediately, or at all events after a few secs. The colloidal solution so obtained contains a mixture of particles which cannot (amicroscopic), and which can (sub-microscopic) be made visible by the ultramicroscope. If this process is repeated, using each time the last colloidal solution obtained to "infect" the new one to be made, the gold particles become larger and larger, until finally they will partly settle out on standing. The colloidal solution used for "infection" acts as a catalyst. The author comes to the conclusion that the process is simply one of doing away with the supersaturation of a crystalloid solution of metallic gold by means of the nuclei of colloidal gold added. It is pointed out that the above results may be used to determine the number and size of the gold particles in the finest suspensions; details are to be published later. [See Abstract No. 1169

(1903).] II. The formation of a colloidal silver solution is accelerated by the addition of a little colloidal solution of gold, the particles of gold in the latter acting as nuclei for the deposition of silver. The colour of the hydrosols of gold and silver does not depend so much on the size of the particles as on the nature of the metal in colloidal solution. It is further shown that colloidal gold solutions in which the size of the particles varies from 2 to 30 μμ show approximately the same intensity of colour in transmitted light, when one compares solutions of approximately the same shade of colour and of the same gold composition. T. S. P.

1627. *Capacity of the Elements of Forming Compounds with each other.* **G. Tammann.** (Zeitschr. Anorg. Chem. 49. 1. pp. 113–121, March 31, 1906. Inst. f. anorg. Chemie d. Univ. Göttingen). Thermal analysis allows of the determination of the number and composition of crystallised phases, consideration of which is necessary in a study of the capability of the elements to form compounds with one another. The author lays down the following rules: (1) The members of a natural group—in the stricter sense of the expression—of elements form no compounds with one another. This is the case, for example, with Cu, Ag, Au, Zn, Cd, Hg, Ge, Sn, Pb, As, Sb, Bi. (2) Either all, or none, of the elements of a natural group form compounds with any one particular element. Exceptions exist to this rule. (3) To the above rules corresponds one found by Kayser and Runge and by Rydberg, which states that as the atomic weight increases in a natural group the lines of the spectrum move towards the red end and the difference between the vibration-numbers of a double line is proportional to the square of the atomic weight. The analogy in the structure of the spectra is to be ascribed to the analogous structure of the atoms of such elements. T. H. P.

1628. *Magneto-optical Determination of the Condition of Benzene Derivatives.* **H. Kauffmann.** (Zeitschr. Phys. Chem. 55. pp. 547–562, June 8, 1906. Techn. Hochschule, Stuttgart, Jan., 1906.)—The author accepts the view that the physical properties of benzene compounds depend on the condition of the radicals present. What is known as the D-condition is characterised by the fact that it is correlated with a maximum value for many of the physical properties of the compounds. In the present paper the author gives an account of an experimental investigation of the magneto-optical properties of a number of organic compounds, and concludes from the results that: (1) Violet-fluorescing compounds give high values of the magneto-optical "anomaly" (the difference between the observed and calculated molecular magnetic rotation); these compounds are in the D-condition. (2) The introduction of CO_2Et or CO_2Me into the nucleus of a substance in the D-condition still further accentuates this condition. (3) The observation that colour and D-condition act in opposite senses is confirmed by the values of the anomaly found. (4) The connection between the magneto-optical anomaly and the chemical and physical properties shows that the same importance must be ascribed to the magnetic rotation of the plane of polarisation of benzene derivatives as to the conductivity of electrolytes. **R. Abegg** (Ibid. 50. 3. pp. 309–314, Aug. 31, 1906) criticises the above. D. H. J.

1629. *Aluminium-Bismuth and Aluminium-Tin Alloys.* **A. G. C. Gwyer.** (Zeitschr. Anorg. Chem. 49. 3. pp. 311–319, May 31, 1906. Metallog. Communication from the Inst. f. anorg. Chemie der Univ., Göttingen.)—The temperature-concentration diagram obtained by the present author for the

Sn-Al series shows a freezing-point curve descending in an unbroken although curved line from the freezing-point of pure Al to a eutectic point only slightly lower than the freezing-point of Sn and occurring at a concentration between 95 and 100 atomic per cent. Sn. There are thus no compounds formed between these metals, and the author obtains the horizontal eutectic line up to an extremely low concentration of Sn, so that he concludes that the two metals are practically insoluble in one another. These results differ from those of other authors cited, but are confirmed both by the microstructure, which always shows a primary crystallisation of Al in a eutectic matrix which increases in amount with the Sn present, and also by a study of the densities of the alloys, which correspond throughout with those calculated on the assumption of simple mixture. In the Al-Bi series the author found that the two metals were only slightly miscible in the fluid state. The freezing-point of Al (675° C.) is only lowered by 5° by the addition of Bi; beyond that point the freezing-point curve remains horizontal; this solid solution of Bi in Al contains about 0·5 atomic per cent. Bi, and at 652° is in equilibrium with Bi crystals and with a fluid containing about 8 atomic per cent. Al. The solubility of Bi crystals in Al decreases rapidly with the temperature and becomes zero at the freezing-point of Bi. Since Bi is so closely related to Sb, and the compound AlSb is known to be slowly formed at about 700°, and very rapidly at 1,100° [see Tammann, Abstract No. 195 (1906)], the author sought to produce a compound AlBi in the same way; but the alloy gave the same cooling-curve after being heated to 1,200° as it had given without this special heating. The author concludes that in the Al-Bi series there are no compounds. W. Ros.

1630. *Effects of Elements on Copper.* **A. H. Hiorns.** (Soc. Chem. Ind., Journ. 25, pp. 616–622; Discussion, pp. 622–624, July 16, 1906. Paper read before the Birmingham and Midland Section.)—In the following series freezing-point curves and microstructure only were investigated. *Cu-As.*—It is claimed that Cu_3As, whose existence is denied by Friedrich [see Abstract No. 2298 (1905)] solidifies at 740° *Cu-Sb.*—660° is found for the solidification of Cu_3Sb, as against Baikoff's 681°, but otherwise the latter's results are confirmed. *Cu-P.*—There is a eutectic at 8·21 per cent. P, freezing at 620°. The saturation-point is at Cu_3P ($P = 14$ per cent.), solidifying at 1,005°. *Cu-Bi.*—The possible unstable compounds Cu_4Bi, Cu_3Bi, Cu_2Bi, and Cu_3Bi_2 are indicated. There is a eutectic at 245° with 97·2 per cent. Bi. *Cu-Pb.*—No horizontal portion in the freezing-point curve was found; there was a continuous slight fall from 45 to 80 per cent. Pb, but otherwise the results agree with Heycock and Neville's. From 5 to 98 per cent. Pb there is an arrest at 326°, corresponding to separation of pure lead. The effects of small additions of one or two of the above metals upon the malleability, as shown by rolling small samples, showed that P had no harmful effect. As, Sb, Pb, and Bi reduce the malleability, As slightly, Bi almost completely. As or P added to Cu containing Sb, Pb, or Bi reduce the brittleness due to the presence of the latter. In the *discussion,* **A. E. Tucker** pointed out that on account of its reducing properties As up to 0·25 and 0·4 per cent. is now specified in Admiralty and locomotive tubes. F. R.

1631. *Crystallography of Iron.* **F. Osmond** and **G. Cartaud.** (Comptes Rendus, 142. pp. 1530–1532, June 25, and 143. pp. 44–46, July 2, 1906. Metallurgie, 3. pp. 522–545, Aug. 8, 1906.)—I. The three modifications of iron (prepared in this case by reducing ferrous chloride at different temperatures by means of hydrogen or the vapour of zinc) were all found to crystallise in the cubic system. In order to detect a difference the pressure-figures formed by the action of a loaded needle on the faces were examined. The crystals of α and γ iron (the latter an isomorphous mixture with Mn or Ni) gave somewhat similar figures, indicating a yielding parallel to the octahedron faces, most marked in the case of γ iron; β iron examined at 800° gave no indications of this yielding. It is further shown that α iron corresponds with α nickel, but γ iron with β nickel. II. If a well-crystallised fragment of manganese steel is quenched in cold water from a temperature of about 1,100°, very fine cleavages are produced parallel to the original octahedral faces. The structure thus produced is very similar to that of the martensite of chilled carbon-steel. In the latter case the cleavage may be attributed to strain produced by the change of volume which accompanies the passage from γ to β iron, and results in fracture with the formation of characteristic figures in which equilateral triangles are conspicuous. Under some conditions this structure is retained even when most of the iron has become transformed, the α iron appearing in the martensite as a pseudomorph of γ iron. On a smaller scale the same structure appears in octahedral meteoric iron. T. M. L.

1632. *Equilibrium and Structure of the Iron-Carbon Alloys.* **C. Benedicks.** (Metallurgie, 3. pp. 393–395, June 22; 425–441, July 8; and pp. 466–476, July 22, 1906.)—Recent work on the iron-carbon system is discussed, and the author supports the following views by results of his experiments: The solidification curves are regarded as consisting of a metastable system, iron-cementite, superposed on a stable system, iron-graphite. The horizontal in the Roozeboom diagram at about 1,030° C. is entirely omitted, the reaction, mixed crystals + graphite = cementite, being regarded as impossible. The metastable eutectic point is given at about 4·2 per cent. carbon, not 5·25, as hitherto assumed. The stable eutectic point lies to the left of this, say at about 4 per cent. carbon, but its position is not known with any greater degree of accuracy than is given by the microstructure of very slowly cooled samples, and probably depends essentially on the amount of Si present. Heyn's statement, however, that graphite is insoluble in iron at all low temperatures cannot be taken as conclusively proved. The modified diagram given is shown to present no discrepancy with well-known facts, such as the malleablising of cast iron. F. R.

1633. *Relation between Type of Fracture and Microstructure of Steel.* **C. O. Bannister.** (Iron and Steel Inst., Journ. 69. pp. 161–175; Correspondence, pp. 176–178, 1906. Carnegie Scholar's Report. Engineering, 81. pp. 770–773, June 8, 1906. Metallurgie, 3. pp. 297–305, May 22, 1906.)—Describes the microstructures associated with typical modes of fracture in a series of tensile test-pieces. The author concludes that there is a distinct relation between the nature of fracture and the microstructure of the steel. Cup fractures are obtained with homogeneous, minutely crystalline, or granular steel which is practically free from flaws of slag and manganese sulphide. Steels giving laminated fractures always contain slag lines or minute "ghost lines" running in parallel straight lines across the specimen in exactly the same directions as the laminations. In the slag lines the elongated patches consist of manganese silicate usually accompanied by manganese sulphide. Steels giving very irregular fractures are generally inferior in quality, and are made up of irregular patches of pearlite and ferrite nearly always accompanied by slag lines or more or less well-developed "ghost lines," which run at different angles or are curved. At least two varieties of "ghost lines" occur in steel, in one of which there is a segregation of the elements C, S, and P, accompanied by a considerable segregation of Si and Mn also, while in the other case there is only a small amount of Si and Mn in excess. Crystalline fractures show a distinct relationship between the size of the crystals and the micro-composition of the steel; when slag and manganese sulphide patches are present in these steels they are arranged in the ferrite bands around the pearlite. Oblique fractures are frequently varieties of laminated fractures, and where lamination is absent there are often indications that rupture occurs in the direction in which the ferrite bands are best developed. Although laminated fractures are always associated with slag lines or "ghosts," yet coarsely crystalline steels containing "ghosts" do not always give laminated fractures. Finally, the prevalence of manganese sulphide and manganese silicate in commercial steels fully justifies their being classed as important constituents. The paper is illustrated with 24 photomicrographs, and in an appendix a method of recording the features of fractures by stereoscopic photographs taken at low magnifications is described. W. Ros.

1634. *Critical Points of Steels by Electric Resistance Method.* **P. Fournel.** (Comptes Rendus, 143. pp. 46–49, July 2, and pp. 287–288, July 30, 1906.)—The author measured the resistances of the specimens (wires) by observing the potential drop along them and along a 1-ohm resistance in series with them; the specimens were heated *in vacuo*. The following results are given for a series of 5 steels:—

	Carbon.	Si	Mn	Ac_1.	Ac_2.	Ac_3.	$a \times 10^4$.
Per cent.	0·08	0·24	0·43	—	775°	880°	3·3
	0·11	0·02	0·35	670°	780°	890°	3·3
	0·22	0·33	0·57	695°	740°	790°	4·3
	0·37	0·126	0·47		730° to 770°		3·8
	1·05	—	0·25		730° to 750°		4·0

The two last specimens showed a point at about 700°; this is thought to be due to the fact that the microscope showed the carbon contents in each case near the periphery of the wire to be less than at the centre. It is not stated, however, whether this observation was made before or after the heating during which the variation of resistance was determined. The curves of resistance place themselves in the same order as that of the sum, for each steel, of the products of the percentages of elements contained, by their atomic weights. The resistances increase according to a linear law until a certain temperature, which depends on the composition of the steel, after which the law is parabolic—corresponding probably, it is considered, to the appearance of β-iron, as this law continues until A_2 is reached. Above 900° the resistance follows a law of the form $R_t = R_{900}(1 + at)$; the values of a, much smaller than below 600°, appear to increase with increasing value of the sum above named. The last column gives the values of $a \times 10^4$. F. R.

1635. *Influence of Silicon, Phosphorus, Manganese, and Aluminium on Chill in Cast Iron.* **E. Adamson.** (Iron and Steel Inst., Journ. 69. pp. 75–97;

Discussion and Correspondence, pp. 98–105, 1906. Engineering, 82. pp. 27–30, July 6; Discussion, 81. pp. 642–643, May 18, 1906. Metallurgie, 3. pp. 306–317, May 22, 1906.)—Describes experiments on a series of cast irons containing varying proportions of the elements named; castings of these compositions were made in chill moulds, and the depth of chill and the mechanical properties (transverse bending tests) were determined and tabulated. The author concludes that the total carbon and its condition in the iron is the dominating factor in the production of chill; the higher the combined carbon the greater the depth of chill; in this connection the author refers to the varieties of graphitic carbon, and describes one variety as "amorphous graphitic carbon." As regards silicon, while admitting the influence of Si in favouring the formation of graphite, the author contends that the differences in temperature at casting and in rate of cooling as between siliceous and other irons may play a greater part in the formation of graphite than is usually supposed. As regards phosphorus, the author considers that the reduction of chill produced may be due to a reduction in the amount of combined carbon, since, although phosphorus makes cast iron brittle, this brittleness is rather of the "soft rotten" nature. Mn is found to have a direct influence in retaining the carbon in the combined state, and consequently increases the depth of chill; further, the higher the Mn the longer the metal retains its initial heat. Al is found to reduce the depth of chill. The author discusses the theory of these effects, as also of the production of deeper chill the hotter the metal when cast. The paper is illustrated by 4 photographs of chilled ingots, and a bibliography of the subject. W. Ros.

1636. *Influence of Manganese on Iron.* **J. O. Arnold** and **F. K. Knowles.** (Iron and Steel Inst., Journ. 69. pp. 106–112; Discussion, pp. 113–124, 1906. Engineering, 81. pp. 670–671; Discussion, pp. 643 and 646, May 18, 1906. Metallurgie, 3. pp. 343–346, May 22, 1906. Iron and Steel Mag. 11. pp. 510–515, June, 1906.)—This is a preliminary note describing in some detail the preparation of the series of a dozen alloys of iron with from 0 to 36 per cent. Mn. Evidence of considerable liquation was found in analyses of the rolled bars, *e.g.*, one contained 28·24 per cent. Mn at the middle, and 26·53 and 35·14 at the two ends respectively; it was not observed which of these corresponded to the head of the ingot. The highest carbon and Si percentages in the series were respectively 0·1 and 0·2. F. R.

1637. *Heat Treatment of Iron and Steel.* (Eng. News, 55. p. 727; Discussion, pp. 727–728, June 28, 1906. Committee Report read before the Amer. Soc. for Testing Materials, June 21, 1906.)—**H. M. Howe** described a furnace consisting of two muffles, one within the other, the outer heated by gas, intended for heat-treatment experiments. **W. Campbell** gave results of tests of small samples of steels containing from 0·7 to 2·04 per cent. carbon, which had been annealed at from 650° to 1,200° C. The best results were obtained at 760°. In replying to the *discussion*, Campbell said that the small amount of carbon freed at 1,070° in 1·6 to 1·7 per cent. carbon steels can be caused to recombine with iron, but he had hitherto been unable to reconvert it in higher carbon steels. F. R.

1638. *Effect of Copper in Steel.* **F. H. Wigham.** (Iron and Steel Inst., Journ. 69. pp. 222–232, 1906. Carnegie Scholar's Report. Mech. Eng. 17. pp. 816–818, June 9, 1906. Metallurgie, 3. pp. 328–334, May 22, 1906.)—Describes a series of tests of steels of the quality used in the manufacture of wire ropes, to which various proportions of copper were added in the ladle; 20 tons of cuprous steel were produced in the course of the research. The author summarises his conclusions thus: (1) Copper is very difficult to alloy with steel so as to obtain a homogeneous mass containing over 2 per cent., even with the addition of Al. (2) Steel alloyed with Cu in the pure form with the addition of Al is not so perfectly mixed as it is when the Cu is added to the charge of steel in the furnace, and more Cu could be employed provided it was in the metal before it was completely converted into steel. (3) In steel containing 0·5 per cent. or more of carbon it is not of practical value to use more than 0·6 per cent. Cu. (4) The steel with 0·25 per cent. Cu, and alloys up to 0·25 per cent. Cu with high carbon (say 0·70 per cent.) give, with or without a high percentage of Mn, a good wire. The author considers it proved that Cu to the extent of 0·25 per cent. is no disadvantage in the manufacture of the best classes of steel wire. W. Ros.

1639. *Variations of the State of Amorphous Carbon with Changes of Temperature.* **O. Manville.** (Comptes Rendus, 142. pp. 1190–1193, May 28, and pp. 1523–1525, June 25, 1906.)—The sample of carbon examined commenced to oxidise at 100°. After heating and cooling 20 times between 15° and 350° formation of carbon dioxide began at 240° and of the monoxide at 300°. After heating at 450° oxidation commenced at a lower temperature, the dioxide forming at 97° and the monoxide at 220°, but the temperature of oxidation was again raised by heating and cooling between 15° and 350°. Carbon which initially began to oxidise to carbon dioxide at 87°, when heated to 450° and quickly cooled began to oxidise at 50°, and this condition persisted even when the carbon was heated and cooled 7 or 8 times between 15° and 350°. When, however, it was again heated to 450° and slowly cooled it became sensitive to oscillations of temperature, and the lowest temperature of oxidation was raised to 245°. T. M. L.

1640. *Liquid Hydrogen Sulphide as a Solvent.* **U. Antony** and **G. Magri.** (Gazzetta Chim. Ital. 35. 1. pp. 206–226, 1905.)—The characters exhibited by liquid H_2S differ widely from those of the gas. Electrically, liquefied H_2S acts as an insulator, and in the neighbourhood of its boiling-point it does not exhibit in its chemical behaviour that analogy with water which would be expected from its chemical composition. As a solvent, it behaves to some extent similarly to CS_2, alcohol, ether, or benzene, but although its solvent powers are relatively extended, its ability to cause dissociation is far less marked than that of water and other strongly dissociating solvents. The salts of energetic bases are not soluble in it, but non-metallic compounds are dissolved by it, giving conducting solutions. Iodine, when dissolved in liquid H_2S, bestows on it very considerable conductivity; phosphorus iodide has the same effect to a less degree, and the haloid compounds of the other non-metals, although they dissolve in very small proportions, give solutions of moderate conductivity. Solutions of certain organic substances—for example, iodoform and tetramethylammonium iodide—yield solutions having conductivities which indicate that organic compounds may become ionised in liquid H_2S. T. H. P.

1641. *Ionic Size in Relation to Physical Properties of Aqueous Solutions.* **W. R. Bousfield.** (Roy. Soc., Phil. Trans. 206. pp. 101–159, June 7, 1906. Proc., Ser. A. 77. pp. 377–384, April 30, 1906. Abstract.)—If D represents the concentration of the dissociated portion of a solute reckoned in the ordinary way and U the concentration of the undissociated portion, there is a linear relationship between log D and log U (Bancroft), so that $K = DU^{-n}$. For weak electrolytes $n = \frac{1}{2}$ (Ostwald's Dilution Law), but for many salts $n = \frac{2}{3}$ (van't Hoff's law) approximately but not exactly. It is now shown that as higher and higher dilutions are reached the value of n decreases in the case of potassium chloride from 0·697 at 0·02—0·05 N to 0·674 at 0·005 N, and in the case of sodium chloride from 0·693 at 0·02—0·05 N to 0·674 at 0·001 N. It is then shown by extrapolation that $n = \frac{2}{3}$ exactly at infinite dilution—*i.e.*, van't Hoff's law holds exactly at extreme dilution. The deviations at lower dilutions are attributed (1) to variations in the viscosity of the solution, and (2) to variations in the size of the (hydrated) ions, both leading to variations in the ionic mobilities, quantities which are assumed constant in the ordinary method of calculating coefficients of ionisation. The former variation is corrected for by multiplying the observed conductivity by the viscosity of the solution, and the variations of ionic magnitude are then calculated on the assumption that the velocity of an ion varies inversely as its radius. A relationship $r = r_\infty (1 + Bh^{-\frac{1}{3}})^{-1}$, is deduced between the radius r of the ion and the dilution expressed in mols. of water h per mol. of salt, B being an arbitrary constant. It is then shown that the conductivity, density, viscosity and freezing-point of a dilute salt solution can be expressed as functions of the radii of the ions of the solute. T. M. L.

1642. *Thermodynamics of Heterogeneous Hydrolytic Equilibrium.* **F. Dolezalek** and **K. Finckh.** (Zeitschr. Anorg. Chem. 50. 1. pp. 82–100, July 9, 1906. Inst. f. physikal. Chemie, Göttingen.)—When a salt and its base are sparingly soluble they can only exist together when in contact with acid of definite concentration. Conversely, if the salt and acid are sparingly soluble, the base must be present in a definite concentration in the solution. In the equilibrium $PbO_2 + 2H_2SO_4 \rightleftarrows Pb(SO_4)_2 + 2H_2O$, the requisite concentration of acid is—

At 0°......55·8 per cent. H_2SO_4 At 25°......64·9 per cent. H_2SO_4
„ 17·2°......62·0 „ „ 40°......68·4 „
At 50°......70·2 per cent. H_2SO_4.

Measurements of e.m.f. against a mercurous sulphate electrode showed that the hydrolysis of the plumbic sulphate probably proceeds through a basic sulphate $PbO(SO_4)$. The heat-change involved in the formation of this salt from the sulphate is calculated from a thermodynamic formula as −6,100 cals., whilst a further −17,700 cals. is involved in the hydrolysis of the basic salt to lead peroxide. The acid-concentration at which the first hydrolysis occurs increases much more slowly with rising temperature than that at which the second occurs; at +140° C. it is calculated that the concentrations would be identical, and the sulphate would be directly hydrolysed to peroxide without formation of basic salt. T. M. L.

1643. *Relation between Electrolytic Dissociation and Refractive Power.* **F. Zecchini.** (Gazzetta Chim. Ital. 35. 2. pp. 65–86, 1905.)—The author has made a large number of measurements of the densities and refractive indices for sodium light and at the ordinary temperature, of solutions of different concentrations of sulphuric, hydrochloric, nitric, acetic, propionic, trichloroacetic, phosphoric, phosphorous, and hydrofluoric acids, sodium and potassium hydroxides, ammonia, potassium nitrate, chloride, acetate, and trichloroacetate, and ammonium nitrate. The numbers obtained lead to the following conclusions. The dissociation of sulphuric acid by dilution with water effects only a very small change in the molecular refraction of the acid. With hydrochloric and nitric acids, the molecular refraction increases slightly with the dilution. The increase scarcely ever amounts to 2·2, which should be the value corresponding with the complete ionisation of a hydrogen atom. Leblanc and Rohland's hypothesis, according to which the hydrogen ion has double the refraction of the hydrogen atom, is therefore regarded by the author as not justified, the small deviations of the molecular refraction being equally well attributable to the anion. The values obtained for solutions of the bases examined indicate no difference in refraction between a hydroxyl group and a hydroxyl ion. In the case of salts, the molecular refraction is mostly independent of the concentration of the solution. The molecular refraction of the water formed in the neutralisation of an acid by a base varies considerably. For the strong acids (nitric, hydrochloric, sulphuric, and trichloroacetic) with the strong bases, potassium and sodium hydroxides, it varies from a minimum of 7·71 with sodium sulphate to a maximum of 8·40 with potassium trichloroacetate, whilst it has the value 5·97 for ammonium nitrate or potassium acetate. No explanation is advanced for these divergences. Further researches are necessary before definite conclusions can be arrived at concerning the influence of dissociation on refraction, the views of Ostwald and Leblanc not being confirmed by the results already obtained. T. H. P.

1644. *Hydration of the Ions.* I. **G. Buchböck.** (Zeitschr. Phys. Chem. 55. pp. 563–588, June 8, 1906. Paper read before the Hungarian Academy of Sciences, Dec. 18, 1905.)—The method adopted was to trace the displacement of a non-electrolytic solute during the electrolysis of a conducting solution. Dilute hydrochloric acid was chosen as the electrolyte, and mannitol and resorcinol as non-electrolytes. In each case it was found that there was a displacement of water towards the anode, showing that the anion was more hydrated than the kathion. Assuming the hydrogen ion to be combined with 1 mol. H_2O, the chlorine ion appears to be combined with 3–4 mols., but the number varies with the concentration both of the hydrogen chloride and of the non-electrolyte. T. M. L.

1645. *Production of Ozone by the Silent Discharge of Direct Current between Metallic Electrodes.* III. **E. Warburg** and **G. Leithäuser.** (Ann. d. Physik, 20. 4. pp. 734–742, July 20, 1906. Communication from the Phys.-Techn. Reichsanstalt.)—The silent discharge can easily be produced between a metallic ball electrode (ball of 2 mm. diam. fused to a Pt wire) and a sheet electrode, especially when the ball is the kathode. With such an arrangement Siemens' ozone apparatus can be worked with direct currents (electric machine or high-voltage battery), while technically alternating currents are preferred. The ozone yields are improved, probably because the current density is smaller at the spherical electrodes than at the previously-used point electrodes [see Abstract No. 1655 (1905)]; from 4 to 8 ball electrodes are connected in parallel. For small concentrations, up to 4 gm. of ozone per m.^{3}, the ball electrode should be the anode and the current density rather high; for higher concentrations, up to 9 gm. of ozone, the ball should be the kathode and the current density low. In the latter case 80 gm. of ozone were produced per kw.-hour. H. B.

1646. *Influence of Moisture and of Temperature on Ozone Production. V.* **E. Warburg** and **G. Leithäuser.** (Ann. d. Physik, 20. 4. pp. 751–758, July 20, 1906. Communication from the Phys.-Techn. Reichsanstalt.)—The air or oxygen is charged with moisture and passed through a Grützmacher refrigerator before entering the ozoniser, which is fitted with ball electrodes [see preceding Abstract]. The presence of moisture decreases the ozone yield, particularly when the luminescence of the gas extends for some distance from the electrode, and more in air than in oxygen. When the gas pressure is kept constant, a rise of temperature up to + 80° affects the ozone yield in oxygen very little, but diminishes it in air. Warburg's hypothesis that the ozone production is essentially a photo-chemical and kathode-chemical reaction [see Abstract No. 603 (1904)], does not maintain that the chemical effects are entirely due to radiation; moving electrons have the same effects as waves of small wave-length, and their movements would be impeded in a moist atmosphere in which water vapour would be condensed upon them. H. B.

1647. *Electrolytic Deposition of Gold from Cyanide Solutions.* **B. Neumann.** (Zeitschr. Elektrochem. 12. pp. 569–578, Aug. 10, 1906. Communication from the Elektrochem. Inst. d. techn. Hochschule, Darmstadt. Electrochem. Ind., N.Y. 4. pp. 297–302, Aug., 1906.)—In the electrolysis of dilute cyanide solutions containing gold, anodes of lead peroxide, as suggested by Andreoli, cannot be used, owing to the fact that the lead cyanide is formed by the action of the cyanogen on the lead. The current-yields obtained in the electrolytic deposition of gold, using lead kathodes and iron anodes, were found to be—

Current Density per sq. m.	Current Yield.	Current Density per sq. m.	Current Yield.
0·25	7·56 per cent.	4·00	0·24 per cent.
0·50	3·81 „	9·00	0·16 „
2·40	0·41 „		

The solution used contained 10 gm. gold per cub. m. Thus the current-yield actually obtained in practice is much below 1 per cent. The author further finds that electrodes of Acheson graphite can be used in dilute cyanide solutions to replace the lead kathodes. They are absolutely necessary if the deposited gold is to be further refined by electrolysis, this being possible in acid solutions of gold chloride, giving a gold of 988 in 1,000 parts fineness. T. S. P.

1648. *Alternating-current Electrolysis.* I. *Electrolysis of Alkali Chlorides.* **A. Coppadoro.** (Gazzetta Chim. Ital. 35. 2. pp. 604–628, 1905.)—On passing a current of 42 alternations per sec. through an aqueous solution of sodium or potassium chloride of about 3-N concentration, the electrodes being of platinum and the temperature between 15° and 30°, no decomposition of the electrolyte occurs until the current density reaches the value 50 amps. per sq. cm. With higher current densities an appreciable amount of hypochlorite is formed. In no case was the formation of chlorate observed. The electrodes undergo disintegration and partly dissolve in the electrolyte; a deposit forms on the bottom of the cell, consisting, with potassium chloride, of platinum black mixed with potassium platinichloride, and in the case of sodium chloride of platinum black alone. If the current density is not too high, the electrodes become platinised, and when this action is complete no more gas is evolved or hypochlorite formed. The hypochlorite is afterwards decomposed into chlorine and oxygen by the catalytic action of the finely-divided Pt suspended in the liquid. Owing to the platinising of the electrodes, which diminishes the polarisation, the p.d. at the electrodes falls appreciably as the electrolysis proceeds. With graphite electrodes a current density of more than 1,000 amps. per sq. cm. is necessary before appreciable formation of hypochlorite occurs; the electrodes then undergo very considerable disintegration. T. H. P.

REFERENCES.

1649. *Physical Properties of the Fluorides of Sulphur, Selenium, and Tellurium.* **E. B. R. Prideaux.** (Chem. Soc., Journ. 89. pp. 316–332, Feb., 1906.)—The melting-points, boiling-points, critical temperatures, specific gravities, molecular volumes, and coefficients of expansion are given. The refractivities of the gases exhibit no approach to an additive law, but the refractivity of any one of them less any number greater than 500, is proportional to its density. T. H. P.

1650. *Sodium-ammonium and Potassium-ammonium.* **A. Joannis.** (Annal. Chim. Phys. 7. pp. 5–118, Jan., 1906.)—The vapour pressures of saturated solutions of sodium-ammonium and potassium-ammonium in liquid ammonia agree well with their dissociation pressures at the same temperature. Determinations of the molecular weights by static and dynamic methods give values corresponding with the formulæ $(NH_3Na)_2$ and $(NH_3K)_2$. The solubilities of these compounds are given for various temperatures and their other properties and reactions are described. T. H. P.

1651. *Solubility of Carbon in Calcium Carbide.* **H. M. Kahn.** (Comptes Rendus, 143. pp. 49–51, July 2, 1906.)—The amount of carbon dissolved by calcium carbide heated in the electric furnace increases with the temperature and with the duration of time of heating, being only limited by the decomposition of the solvent. W. H. Si.

1652. *Solidification of Inorganic Salts and Salt Mixtures.* I. *Solidification of Pure Salts.* **W. Plato.** (Zeitschr. Phys. Chem. 55. pp. 721–737, June 26, 1906. Anorgan. and elektrochem. Laborat. d. techn. Hochschule, Danzig.)—The author has studied the cooling-curves of several salts, the temperature of cooling in the furnace being so regulated that the cooling-curve of the substance was practically a straight line. From the duration of the temperature-arrest and rate of cooling of the partially solidified material, the heat of fusion and the specific heat of the solid could be calculated. The numbers were found in agreement with those determined experimentally. A. F.

1653. *Nature of Liquid Crystals.* III. **G. Tammann.** (Ann. d. Physik, 19. 2. pp. 421–425, Feb. 8, 1906. Inst. f. anorg. Chemie, Göttingen.)

1654. *Stratified Structures.* **R. E. Liesegang.** (Zeitschr. Anorg. Chem. 48. 4. pp. 364–366, March 3, 1906.)—Describes the formation of stratified layers in precipitates formed in gelatine and similar solutions, and shows, contrary to the views of Hausmann, that crystalline precipitates form these layers as readily as amorphous ones. The author has also observed stratification in the absence of colloidal solvents. W. Ros.

1655. *Liquid and "Apparently Living" Crystals.* **O. Lehmann.** (Ann. d. Physik, 20. 1. pp. 63–76, and 77–86, May 11, 1906.)—Two further papers on the structure and properties of the type of substance dealt with in Abstracts Nos. 825 and 992 (1906).